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## ECONOMICS AND HUMAN FACTORS IN NATIONALIZATION

DURING the past two years, the Acton Society Trust has published a series of twelve research papers dealing with various aspects of the nationalized industries of Britain. These objective studies have made it clear that the application of nationalization to industry has raised problems of an entirely different order from those raised by the public boards or corporations, such as the British Broadcasting Corporation, the Central Electricity Board and the London Passenger Transport Board, which we knew before the Second World War. Some problems, such as those of public accountability and control, of size or of decentralization, were encountered in the earlier experiments in public ownership, and to-day call for solutions differing in degree rather than in kind. Others, it is now apparent, are independent of the form of ownership, but may be more acute under public ownership. Moreover, where industry is concerned, mistakes in organization, control or operation can have most calamitous results on the climate of work, as was indicated in a longer study of training and promotion in nationalized industry which the Acton Society Trust has also issued.

Although the Acton Society Trust has given such an admirable lead to objective discussion, the conclusion of this series of research papers does not mean an end to its studies in this field. A further report on the effect of nationalization on the managers of the working units of nationalized industry is expected to be followed by others on the problems of making changes in large-scale industry, and on the human effects of size of unit. Further, investigations of the Acton Society Trust have been followed by a considerable amount of objective discussion of nationalization through the medium of the technical press and in the proceedings of the Select Committee on Nationalized Industries.

What emerges most clearly from much of this discussion is the unreality of some of the political arguments on nationalization. This is largely because the purposes of nationalization and the purposes of a nationalized industry are by no means necessarily the same. The former are political ; the latter are economic. Industries exist for economic purposes, and the attachment or not of the label 'nationalized' does not affect those purposes, though it may change, for better or for worse, the whole climate of work in the industry and raise expectations about the functions of the industry and its responsibilities for service to the community.

This has been clear enough throughout the Acton Society Trust studies which, for all the importance rightly attached to the point of view of those engaged in the industry and of securing their understanding and co-operation, have not made the mistake of dealing with the problem as one of theory rather than practice. The right organization, it is accepted, is the one that leads, within the context of public ownership, to the right decisions, not necessarily that which best accords with administrative theory. The

right method of accountability or control is that which encourages initiative and efficiency, rather than that which is most convenient for financial accountability; and the test of efficiency in a nationalized industry is economic, not administrative.

Now we have a study of the future of nationalization by H. A. Clegg, Fellow of Nuffield College, and T. E. Chester, of the Acton Society Trust*. In this book, the problem of labour relations in the nationalized industries and the bearing of the organization of the industries upon such relations are dismissed rather briefly, because one of the authors has discussed this theme at length in an earlier book ("Industrial Democracy and Nationalisation". H. A. Clegg. Oxford: Basil Blackwood, 1951). None the less, they write clearly on the confusion of purposes which has sometimes frustrated the work of consultative committees; and the two points which they stress, that if an organization is to be tolerable the worker must have within reach someone who has the power to take decisions, and that the selection of managers for their ability to handle men in the conditions of to-day is of first-order importance, show that the authors do not make a fetish of organization. They do not imagine that the problems of large-scale organization can be spirited away by the device of electing managements. Nevertheless, this well-written book, with its clear and admirable argument, tends to over-simplify the issues and to over-stress the importance of organization. Its concern is essentially with the patterns of organization in the nationalized industries. It does not suggest that any one pattern is necessarily desirable for all the industries that have been or may be nationalized; but it does incline to the view that if the most appropriate and efficient form of organization from the administrative point of view is discovered and applied to each industry, all will be well. The line of approach is to describe objectively the way in which the existing forms of organization came to be developed, whether on doctrinaire or on pragmatic grounds. The existing structures are dealt with in some detail, and the authors then discuss these forms of organization and whether they could be improved. The proposals they make for re-organization are based essentially on the thesis that if we can determine why the nationalized industries have failed to achieve, in a satisfactory measure, the purposes for which the change in ownership and organization was made, we need only to specify what different organization would be better suited to that purpose.

To suggest that the answers to these questions will of themselves settle the future of the nationalized industries is a gross over-simplification and ignores some of the main problems; nor do the authors really appear to believe in this simplification. Although they largely ignore the economic purposes and aspects of industry, their advocacy of the most efficient and appropriate organization for the execution of policy shows that they are aware that both organization and policy must have regard to what is humanly possible. As already noted, in their reference to industrial relations the authors recognize the importance of effective contact between workers and those who have power to take decisions, and in their remarks on the selection of managers they add that there is little sense in putting forward a scheme for re-organizing nationalized industry unless it can be shown that men can be found to make it work.

This question is dealt with at considerable length in the concluding chapter, and besides being one of immediate interest to the scientist or technologist, the discussion well illustrates one of the central propositions on which Mr. Clegg and Mr. Chester base their proposals. "The only criteria," they write (p. 132), "which we can even try to handle are impressions about the effect of forms of organization on those who work in the nationalized industries, and guesses about the probable effect upon them of changes in organization. We assume that there is a connexion between their state of mind and 'efficiency' (measured in terms of quantities, qualities and prices), without being able to demonstrate the existence of the connection." Thus, they do not give an unqualified answer of 'yes' to the questions whether it is not likely that the boards will have found and used the best men available, and whether they are not developing schemes of promotion and training which will open the highest posts to talent wherever in the industry it is to be found. The authors do not discuss some of the obstacles to a satisfactory promotion policy which were noted by the Acton Society Trust, but they do suggest that more could be done to foster and strengthen the desirable human qualities of leadership where they exist, and that more weight could be given to these qualities by selection boards. They also comment that it would be more sensible to construct an organization without national management boards than to hope that some day the supermen needed to run them may be forthcoming.

Such considerations, among others, lead Mr. Clegg and Mr. Chester to advance proposals which would have the advantage that more first-rate men would be available for the posts of operational managers, whose status would be enhanced by a reduction in the number of their superiors. This should also make the posts more attractive to first-rate men; and if this happens, industrial relations should benefit handsomely. Incidentally, their proposals, which find further support here in recent management studies by J. F. Scott and R. P. Lynton, would also result in less lavish demands for talent and genius by the nationalized industries, which in itself would assist the best use of talent.

The second proposition on which Mr. Clegg and Mr. Chester base their proposals is also one favouring decentralization and small-scale operation. It is implicit in the foregoing argument that some of the existing weaknesses of nationalized industry are due to failure to fill many of the posts with men of the requisite ability. Even, however, had men of the desirable calibre been forthcoming, on Mr. Clegg and Mr. Chester's second proposition the position would still have been unsatisfactory. This proposition is

* The Future of Nationalization. By H. A. Clegg and T. E. Chester. Pp. ix+211. (Oxford: Basil Blackwell, 1953.) 12s. 6d. net.

that the type of organization imposed on the industries nationalized since 1945 is based on the erroneous conclusion that, because some functions of the industries required large-scale organization, all other functions also required large-scale organization.

The great merit of the detached and scholarly analysis of nationalization presented in this book is that it demonstrates the fallacy of this view. The authors point out that such an arrangement must result in over-centralization, both because once central bodies have been given over-all responsibility for their industries by Parliament, those with grievances against subordinate authorities will pursue them to the central body or the Minister, and also because the general responsibility of the central bodies leads to a hierarchical organization in which effective decentralization is impossible. Both from the criteria of how people can best work together and achieve the maximum administrative efficiency, and from the practical point of view of finding the managerial ability, they urge that smaller units for general management are desirable. Parliament, they suggest, should decide what functions can and should be exercised over an area wider than the individual undertaking, and place responsibility for these functions—and for these alone—upon appropriate regional and national authorities. In other words, we are brought back to the second principle that, in decisions to centralize authority, the *onus probandi* should always rest with those urging centralization. The book is thus a challenge to constructive thought and to further investigations as to the design of such appropriate authorities, though some indication is given with regard to promising lines; the suggestions at least merit examination and discussion in an atmosphere as free from political prejudice as the spirit in which they are advanced. They are not proposals for denationalization; indeed, the authors believe that nationalization is compatible with small-scale operation. Nor do they exaggerate the importance of the proposals or the magnitude of their probable effects. They believe that improved organization can lessen the likelihood of disputes and facilitate their handling.

This book should certainly encourage a more objective examination of the future of nationalization itself, as well as of the organization of the nationalized industries. It should equally discourage any over-optimistic view that present difficulties will work themselves out if the industries are left alone. It is pointed out, for example, that since under directed training schemes potential managers gain practical experience under existing managers, there is danger that bad practices may be perpetuated, and again that some organizations are so constructed that good habits are discouraged and bad habits develop without restraint. As in the Acton Society Trust reports, it is recognized that decentralization is primarily a problem of the adjustment of human relations. Parliament, it is suggested, should lay down a clear and reasonable set of rules for each nationalized industry—a set of rules which would support good habits as the industries grow to strength and maturity. This is reasonable doctrine; but, even if the appropriate form of organization is discovered and adopted, it will still not ensure that the right policies are adopted, and it is above all on the formulation and adoption of the right policies that the future of the nationalized industries depends. Here is where further inquiry is needed, and how deep and wide it may have to go is sufficiently illustrated by reference to the Ridley Report on the national policy for the use of fuel and power resources in Britain. That Report placed the responsibility for the formulation of policy fairly and squarely on the Minister of Fuel and Power. The Ridley Committee regarded the functions of co-ordination and control of policy as the main reason for the existence of a Minister of Fuel and Power. Failure to ensure that the nationalized industries are administered in the national and not in a sectional interest is not a failure of organization, but a failure of ministerial leadership for which successive Governments must accept responsibility. Indeed, so far from having formulated a national policy, the present Minister could only say in the House of Commons on May 18—nine months after the Ridley Committee reported—that he hoped to make a statement soon after the House reassembled from the Whitsuntide and Coronation recess; this sufficiently demonstrates that much more is required than the discovery and use of means of making national ownership and national planning compatible with small-scale operation. Mr. Clegg and Mr. Chester point in the right direction; but something more than fresh thinking about the organization of the nationalized industries is required to secure their efficient working, and the success of what is admitted by both political parties to be a large-scale experiment. Mr. Clegg and Mr. Chester may have limited their survey too severely and over-emphasized one aspect of the problem. The solid merits of their book may none the less stimulate the wider thinking and inquiries that are necessary for ensuring that the appropriate organization, once determined, is entrusted with the right policy to execute.

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## THE COMMUNITY CONCEPT IN ECOLOGY

### Natural Communities

By Lee R. Dice. Pp. xi+547. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1952.) 45*s*. net.

THE author says that the purpose of his book is "to describe the more important methods and concepts of one division of biology, that dealing with natural communities. If the reader gains a better understanding of the importance of ecological communities to the world of life, I shall be pleased. It is my earnest hope moreover, that this exposition may stimulate further investigation in this complex and as yet little understood field of biology". This quotation is important because it expresses exactly not only the function of the book but also the impression it has made on at least one reader. It also shows how well the author has succeeded in his task, for the book may indeed be regarded as one of the most complete statements of ecology that has so

far appeared, and one, it should be added, written with quite exceptional clarity of expression.

Very properly this considerable book is largely a monument to the enormous amount of excellent and untiring work which has gone to make the modern subject of ecology; but it is written in so balanced and judicious a way that it also shows quite clearly how much the subject still labours under disabilities inherent in our usual methods of studying the interrelations of living things. We should neither magnify nor ignore imperfections, but many will agree that there is, about much ecology, an undefinable lack of reality which suggests something at fault in our methods of approaching it, and since this is also the conclusion to which readers of Dr. Dice's book are likely to come, it is perhaps most useful here to notice how his presentation helps to throw light upon the causes as well as the symptoms of this *malaise*. It would seem that they are basically three.

One is that ecologists have not yet really reached the point of regarding the ecologic community as a single coherent unity. This is chiefly due to that specialization which still makes biologists either botanists or zoologists; but this is not all, and while botanists, secure in the knowledge of the fundamental role of their subject, tend to ignore the animal side of ecology, the zoologists show a not unnatural tendency to try, by a similar process, to balance the two, and this almost inevitably gives a sense of unreality to the whole. Plant life and animal life are neither strictly comparable nor mutually incompatible; they are the two variable ingredients which make up the biological scene. The terrifying list of qualifications suggested by the author as the necessary equipment of the perfect ecologist suggests that this problem may be difficult to solve, but at least he indicates the direction of its solution.

Another cause is the difficulty of getting free from the anthropocentric point of view. Especially it seems difficult to realize, and consistently to maintain the realization, that animals and plants in natural communities may not react upon one another in the same fashion and with the same motivation as do members of human societies, and that some of the methods which may be of value in the study of human economics are not equally applicable to the study of non-human ecology. In this connexion the notably guarded attitude of Dr. Dice towards some aspects of statistical ecology will win the approval of many.

The third and deepest reason for dissatisfaction is our failure to abandon outmoded biological conceptions, and this has two main aspects. More important, because of its profound significance to the world in general, is what may be called the 'Nature red in tooth and claw' fallacy. One would imagine that the influence which such a belief has had on human affairs in the past half-century would at least raise doubts about its validity; but even more odd is the apparent continuing failure to admit that the very existence of a science of 'natural communities' belies it, for if Nature was indeed as the poet described it, its condition would be chaotic and in a perpetual state of disequilibrium. If there were nothing else to thank Dr. Dice for, there is the support his book gives to the view that Nature is essentially a state of beautiful and delicate balance to which each and every member makes its due, but only due, contribution.

Inextricably involved with this fallacy is the vexed question of that seemingly immortal phoenix 'adaptation'. One suspects that the author views this side of his theme with some reluctance, for it is here, when he tries to deal faithfully with this treacherous subject, that he loses his usual sureness of touch. Like many others, he tries as best he can to maintain the position by depicting biological 'adaptation' as something far from the general understanding of that word; but the inconsistencies into which his quite proper attempt to deal with this matter force him are at once the chief weakness in the book and the clearest comment on the adaptationist point of view. But these imperfections are not of his making. They are part of the still generally current story, and it is the extraordinarily undeniable way in which Dr. Dice's book exposes the real value of such things that makes it so important a contribution to the better understanding of ecology. Ronald Good

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## DANA'S "MINERALOGY"

### The System of Mineralogy of James Dwight Dana and Edward Salisbury Dana, Yale University, 1837–1892

Seventh edition, entirely rewritten and greatly enlarged, by Charles Palache, the late Harry Berman, and Clifford Frondel. Vol. 2: Halides, Nitrates, Borates, Carbonates, Sulfates, Phosphates, Arsenates, Tungstates, Molybdates, etc. Pp. xi+1124. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 120*s*. net.

### Dana's Manual of Mineralogy

Sixteenth edition, revised by Prof. Cornelius S. Hurlbut, Jr. Pp. viii+530. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 48*s*. net.

THERE can be few scientific text-books published more than a hundred years ago that are still 'alive', but James Dwight Dana's classic, "System of Mineralogy", which first appeared in New Haven, in 1837, is one. It was even then a considerable work of 572 pages, but the author would be a proud man to-day could he see his first book in its latest form. It is now more than fifty years since his mortal remains were laid to rest, but it can truly be said that his soul goes marching on.

The last edition of the "System", the sixth, was published by his son, Edward S. Dana, in 1892, and this was kept up to date by the issue of three supplements. In 1915 the decision was made to prepare an entirely new edition, and the work was entrusted to the late Prof. W. E. Ford, of Yale University. Since then many specialists, too numerous to mention, have assisted in preparing the latest edition; and financial assistance has been received from funds at the disposal of the Geological Society of America and Harvard University. A word of praise is also due to the publishers, John Wiley and Sons, Inc., of New York, who have been associated with the book since 1844, when they published the second edition; they have agreed to take no profit from the sale of the book until the grant from the Geological Society has been repaid.

The first volume of the new edition appeared in 1944, and dealt with the elements, sulphides, sulphosalts and oxides. Vol. 2, the volume at present under notice, is dated 1951 and includes halides, nitrates, borates, carbonates, sulphates, phosphates, arsenates, etc. The silicates will be described in a third volume, yet to appear.

In Vol. 2, not only has the text been enlarged and the presentation modernized, but also every detail has been thoroughly revised in the light of the great amount of research into the mineralogical and crystallographic sciences carried out since the last edition appeared. This is a book which needs no recommendation to mineralogists, and is likely to remain a standard work of reference for many years.

Dana's smaller "Manual of Mineralogy", intended for students, amateur collectors and mining geologists, has had an almost equally long and distinguished career, the first edition having appeared in 1848. The main changes in the latest edition are the inclusion of some introductory matter of a general character and the addition of a separate section on crystal chemistry.

## FOOD SUPPLY AND CONSUMPTION IN GREAT BRITAIN

### Britain's Food Supplies

By Dr. K. G. Fenelon. Pp. ix+212. (London: Methuen and Co., Ltd., 1952.) 15*s*. net.

ON three counts at least this is a useful and timely book. Since he was, for a while, director of statistics and intelligence at the Ministry of Food, Dr. K. G. Fenelon is well fitted to select the contents of the twenty-seven pages of tables, with which it closes; they are conveniently arranged for reference. The story of British war-time and post-war food problems, which consumes about half his space, is as concise and readable a description as one could find; it is the kind of thing that should be compulsory reading for all students of dietetics and catering. But flowing through the book (I am not sure how far Dr. Fenelon is aware of it) runs a strain of dramatic irony, as Britain's food position is traced from its eighteenth-century days of virtual self-sufficiency to the chronic crisis in which it is now involved.

Carefully studied with this in view, the work is a salutary one. The text is announced in the opening sentences: "Most countries produce the bulk of their own food. Only a very few import more than a third of their total food supply and among these Britain is outstanding as by far the largest buyer, taking before the Second World War no less than 40 per cent of the world's total trade in food and animal feeding stuffs". On the last page the narrative concludes with a quotation from Adam Smith; if Britain, says Smith, cannot achieve an all-round increase in productivity, then she will have to "endeavour to accommodate her future views and designs to the real mediocrity of her circumstances".

The interval between these sentences is filled with illustrative facts and figures. For more than fifty pages Dr. Fenelon reveals the slowly increasing dependence of Britain upon world food markets; incidentally, he shows the corresponding dependence of world food markets upon the British consumer. Thus, for example, "Britain was [before the Second World War] far and away the largest world buyer of meat and bacon, taking something like three-quarters of the world's export trade of some 2 million tons annually" (p. 50); or again, "Britain imported about four-fifths of the world's exports of butter and about half of those of cheese and eggs" (p. 51). But later comes the irony of shrinking supplies, and the gradual diversion of products. What of Australia? "Before the war, 70 per cent of the wheat crop was exported, whereas in 1947–48 only 43 per cent went abroad. Australia's contribution to world food supplies will be a considerable factor during the next decade or so, but beyond that period it appears doubtful if there will be any large exportable surplus. During the last twenty years population has risen by over 2½ millions. . . ." (p. 142). And South Africa? "Meat was exported before the war from the Union and Southern Rhodesia, but Union meat exports have now ceased, and those from Rhodesia are likely to disappear before long. The chief reason is increased consumption per person and this is also the case with sugar and wheat. The Union now needs to import 40 per cent of its wheat and flour requirements . . ." (p. 144).

There are brief but useful chapters on the various international schemes and agencies for controlling or raising food production; and these, together with the survey of world food supplies and consumption-levels, serve to set the British position in its global context. The bibliography and the index are satisfactory.

F. Le Gros Clark

## OUTLINE OF RADIO ASTRONOMY

### Radio Astronomy

By Prof. Bernard Lovell and Dr. J. A. Clegg. (Frontiers of Science Series.) Pp. 238+8 plates. (London: Chapman and Hall, Ltd., 1952.) 16*s*. net.

MAJOR advances in science often come about when a technique developed for one type of investigation is applied to another. Radio astronomy is an excellent example of this. During the past seven years the use of radio methods has revealed the presence of hitherto unsuspected meteor streams and has enabled the velocities of meteors to be measured; it has added considerably to our knowledge of the solar corona both under quiet and disturbed conditions; and it has revealed the existence of numerous 'radio stars' which emit strongly in the radio-frequency portion of the spectrum.

"Radio Astronomy", by A. C. B. Lovell and J. A. Clegg, gives an admirable and concise account of this new work. The book is in the series "Frontiers of Science" edited by Prof. Lovell and admirably fulfils what is stated to be the aim of that series: "the filling of a gap in Scientific publications between the very elementary expositions and the specialist text books". By a remarkable feat of compression the authors have succeeded in presenting, in successive thirds of this small book: the essential ideas of positional astronomy and radar techniques; a most readable and instructive account of what has been achieved in the study of meteors by radio methods; and a summarizing account of the results achieved in the study of radio waves emitted by the sun and other bodies outside the earth. Anyone with a knowledge of physics to the standard of 'university entrance' will find the book most instructive and readable, and it will be especially useful to those working in other branches of physics and to anyone starting research in radio astronomy.

In a book on radio astronomy it is perhaps a little surprising to find so large a proportion devoted to the radio detection of meteors. This part, which deals with a field of knowledge in which the authors are themselves leaders, is most illuminating and stimulating, and is the best part of the book. The part on radio emission from extra-terrestrial bodies

(what is usually called radio astronomy) is, by comparison, less impressive. It naturally takes the form more of a catalogue of the work of others, without much attempt at criticism, but it is an excellent and readable catalogue.

The clear and precise introductory chapters on positional astronomy and on radar technique and aerials could well be read by anyone interested in these subjects, quite apart from their application to radio astronomy. I feel that it is unfortunate that the excellent chapter on radar methods is marred by the quoting of particular units after algebraic expressions which are correct in all system of units. Although I know that this failing is common to those who use m.k.s. systems, I nevertheless consider it is wrong in principle and wish to make my protest against it. J. A. Ratcliffe

## SOIL PHYSICS IN AGRONOMY

### Soil Physical Conditions and Plant Growth

Compiled by the Joint Committee on Soil Tilth, American Society of Agronomy, American Society of Agricultural Engineers. Byron T. Shaw, Editor. (Agronomy, a Series of Monographs, Vol. 2.) Pp. xv+491. (New York: Academic Press, Inc., 1952.) 8.50 dollars.

FOR want of a better definition, agronomy can be regarded as agricultural technology in which the emphasis in research is on "How?" rather than on "Why?". This monograph, written by ten authors and dealing with five aspects of the interrelation of soil conditions and plant growth, conforms easily to such a definition, for it presents detailed surveys of existing knowledge supplemented by extensive lists of references that enhance the value of the book. The sections differ in length and quality. The first, on the soil as a physical system (forty-two pages), gives a background for those who need it; the second, on mechanical impedance and plant growth, fills thirty pages—more than enough to reveal our complete ignorance of the topic. Then comes an admirable survey of soil water (a hundred and eighty pages), which, though based mainly on American experience, remains aware that there are water problems elsewhere in the world and that much useful work has been done toward solving them. The section on soil aeration (fifty pages) satisfies an important need for a dispassionate survey of an aspect of soil physics that is usually discussed in somewhat mystical terms; and the long final chapter on soil temperature (a hundred and seventy-eight pages) very reasonably brings in discussions of the effect of air temperature too. Many aspects of the problem are considered; but, whereas the length of the chapter on soil water is a measure of the importance of water in plant growth, the length of this chapter is probably a result of the ease with which soil temperature can be measured.

There is much to criticize in the book, but nearly all such criticism is of the primary authors and not of the compilers; and this is the cause of a slight feeling of disappointment. Though the personal touch does appear here and there, it is too infrequent, possibly because the compilers have had behind them a panel of twenty-five experts who reviewed the manuscript and offered comments on all or parts of it. Some day, perhaps, out of this book and from among these compilers another book may grow, a more single-minded book based on ideas rather than on facts, with a title "Soil Conditions in the Physics of Plant Growth".

Printing and binding are good, but the price is high. A copy—or copies, for it will be well used—should be in the library of every institution that encourages research or teaching in agricultural science. H. L. Penman

## TABLES OF PERCENTAGE COMPOSITION OF ORGANIC COMPOUNDS

### Prozenttabellen organischer Verbindungen (Tables of Percentage Composition of Organic Compounds)

C—H—O, C—H—N, C—H—O—N, C—H; C—H—S, C—H—O—S, C—H—N—S, C—H—O—N—S. By Dr. H. Gysel. Pp. xxii+637. (Basel: Verlag Birkhäuser, 1951.) 125 francs.

THE ancillary services provided by the micro-analyst, the spectroscopist (ultra-violet and infra-red) and the X-ray crystallographer have made the life of the modern organic chemist seem feather-bedded by comparison with that of his older colleagues. Dr. H. Gysel's tables supply a further aid which, although not of the same quality as the services mentioned, will effect a considerable saving of time spent on purely mechanical processes. Apart from a short explanatory preface, in three languages, the book consists entirely of tables. The percentage composition to 0·001 per cent has been calculated for about seventy thousand formulæ. The figures have been rounded off to two decimal places, and the molecular weights are also given. At a rough estimate the figures represent upwards of a quarter of a million calculations. It is easy to accept the statement that "this book involved a considerable amount of work".

The tables relate to CH compounds up to $C_{60}$, CHO compounds to $C_{32}$, CHN compounds to $C_{30}$, and CHON compounds to $C_{40}$. It is not easy to follow the logic of the decision to include $C_{40}$–$C_{60}$ compounds "only insofar as they have already appeared in the literature". The chemist who uses these tables will often be more interested in compounds which have not been described previously. For the compounds included in the tables, it is possible to determine, by inspection, the percentages of the elements, including oxygen. To assist in the calculation of the composition of compounds containing other elements (except sulphur, which can be dealt with from the simple relationship of its atomic weight to that of oxygen) supplementary tables give multiples of the atomic weights of common elements and of the weights of simple atomic groups. There are also tables of the specific gravity of nitrogen at various temperatures and pressures, and of the logarithms of these values.

By the use of these tables I have been able to detect typographical errors that have crept in during the various stages of drafting and typing papers, and some errors have been found even in composition figures published in the chemical journals. Whether the tables are "almost free from errors" as claimed can only be determined by much more prolonged use. It is unfortunate that the high price of the tables will restrict their availability. J. W. Cook

## Literature for an Age of Science

By Prof. Hyman Levy and Helen Spalding. Pp. x+250. (London: Methuen and Co., Ltd., 1952.) 15*s*. net.

THIS book is a joint venture by two people whose disciplines lie respectively in the fields of science and literature. At the outset, it can be said that their work is both timely and important. It extends into a larger sphere, and away from the detailed mechanism of criticism—the rational treatment of literature such as was suggested by I. Richards in his "Principles of Literary Criticism".

Prof. H. Levy and Helen Spalding attempt to see literature as a feature of social life and to judge its importance and its potentialities within this life. The functions of poetry, drama and the novel are reviewed in relation to modern sociological ideas. Science and the arts are aspects of one venture; they should be complementary and mutually supporting. But at present we are far from realizing this ideal: a scientist or a technologist can express the quality of truth in his work and can thrive, whereas a writer who expresses an important but unpalatable truth cannot expect encouragement. Truth in science can be commercially useful, but truth in literature cannot always be. Commerce is not concerned with the whole of truth, and yet human beings are. Science, with the material rewards and the intellectual satisfactions heavily weighted in its favour, tends to attract to itself the intellectual vitality of society to the relative impoverishment of the arts.

There are few inducements to help equalize the flow of creative energy in all directions, for the pressures that are responsible for the actual distribution of this energy are in no way consciously controlled or directed but are left to the random play of social forces only dimly apprehended. Even the academic rewards given for creative work in science are not given for creative work in literature, though the desiccated dissection (not even worthy of printing), of a minor poet, may bring its producer a Ph.D.

Nevertheless, this near-Marxist view of literature presented by the authors will be considered partial, if not perverse, by most readers. It is notoriously lacking in human individual qualities, it knows nothing of ultimate values and it tends to be unimaginative, arid and unentertaining.

W. L. SUMNER

## Practical Organic Chemistry

By Dr. Frederick George Mann and Dr. Bernard Charles Saunders. Third edition. Pp. xv+466. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1952.) 18*s*. net.

IN the third edition of this popular manual, the authors have made a thorough revision of the text, based on sixteen years of experience of its use in the laboratory, and have somewhat raised the general standard by an increase in the range of the preparations and an extension of the section dealing with identifications, greater emphasis now being placed on the preparation of crystalline derivatives. A new short section, which should prove particularly useful in view of the increased cost of chemicals, describes the use of apparatus for small-scale manipulations. The macro methods of estimation of carbon, hydrogen and nitrogen have at last disappeared, and have been replaced by a section on semi-micro methods of analysis.

Descriptions of methods of manipulation and experimental directions throughout are extremely clear and precise, and the theoretical notes preceding each experiment should enable the student to understand the general principles involved. The scope of the book is perhaps still too limited to justify the authors' claim that it should now cater fully for the needs of students working for honours degrees; it certainly meets admirably the requirements of pass-degree students, and the price, although about double that of the second edition, is still very moderate by current standards.

C. BUCHANAN

## Hobhouse Memorial Lectures, 1941–50

Pp. vii+268. (London: Oxford University Press, 1952.) 17*s*. 6*d*. net.

THIS collection of lectures by distinguished social scientists and philosophers shows that, though Hobhouse's system of thought and belief has been severely shaken in the troubled years that have succeeded his death, efforts are still being made to follow many of the lines he laid down. C. P. Scott, an intimate colleague and friend, wrote that "his deepest instinctive belief and hope were in human progress", and that his life and work represented "an imposing expression of intellectual power allied to an almost childlike friendliness". All these things have since come under criticism, and it will be reassuring to many to find evidence in the Memorial Lectures that the kinds of intellectual courage and optimism for which Hobhouse is remembered are not yet extinguished.

The most impressive of the lectures, which shows the deepest knowledge of Hobhouse's work, and makes an attempt to translate his ideas into the mould of present-day thinking, is by Prof. H. L. Beales, who defends the constructive liberalism with which Hobhouse was associated from the attacks of critics of 'planning'. Hobhouse himself would also have been greatly interested by Dr. C. E. Raven's re-examination of the relationships between religion and science, which, as he points out, was very relevant to Hobhouse's central interests and is of supreme importance at the present time. Many issues which would have excited Hobhouse's mind are, moreover, touched on by Prof. Gordon Childe in his lecture on "Social Worlds of Knowledge".

## Beautifying India

By M. S. Randhawa. Pp. xviii+224+23 plates. (Delhi and Bombay: Rajkamal Publications, Ltd., 1950.) 15 rupees; 28*s*.

THIS is virtually a miscellany on art, science and æsthetics in which the author is concerned with the problem of beautifying his native land—this to coincide with what he hopes and believes to be the inception of a period of prosperity. While one may not agree with all the author's views and opinions, one cannot fail to appreciate his enthusiasm, the lucid exposition of his views, and his evident sincerity. Like other tropical regions, India needs beautifying. In the author's view, this will only come about by a general awakening of interest and a conscious effort to bring to bear the right kind of action—that is, a conscious planning of the flora and fauna with the object of creating a pleasing pattern of colour throughout the land. Bio-æsthetic planning is essentially planned ecology, and, in its application to the Indian scene, would take the form of a widespread planting and appropriate massing of ornamental flowering trees. On this subject, the author has brought together much useful information which may well have a wider application to tropical regions in general.

# SCURVY IN RETROSPECT

By Dr. LESLIE J. HARRIS
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TWO hundred years ago, in 1753 at Edinburgh, was published Lind's "Treatise on Scurvy"—or to give it its full title: "A Treatise of the Scurvy, in Three Parts, Containing an Inquiry into the Nature, Causes and Cure of that Disease, together with a Critical and Chronological View of what has been Published on the Subject". This is almost the first book to deal exclusively with what we should now call a vitamin-deficiency disease. But it is not quite the first, because in 1650 Glisson of Cambridge had published his famous work on "Rickets"; and five years earlier still Whistler from Oxford had brought out, in Leyden, as his M.D. thesis, the less well known but important "De morbo puerili Anglorum quem patrio idiomate indigenæ vocant, The Rickets".

To mark the bicentenary of Lind's noted book, and imbued no doubt with a due sense of civic pride, Drs. C. P. Stewart and A. P. Meiklejohn, of the University of Edinburgh, recently organized a series of celebrations in that city. These included: a scientific conference on vitamin C, held under the auspices of the Nutrition Society of Great Britain and attended by leading experts from other parts of the world; an honorary degree ceremony, together with other academic and social occasions; and the re-issue of Lind's "Treatise", complete with new explanatory notes.

Dr. C. P. Stewart and Dr. D. Guthrie, who have been responsible for the editing of this reprint of Lind's first edition, have done their work admirably. In this volume*, in addition to the careful re-issue of the "Treatise" in modern typography, there are included also contributions by C. P. Stewart (a description of "The Third Edition of the *Treatise*"), Surgeon Vice-Admiral Sir Sheldon F. Dudley ("The Lind Tradition in the Royal Naval Medical Service"), D. Guthrie and A. P. Meiklejohn ("James Lind and Some of His Contemporaries"), C. P. Stewart ("Scurvy in the Nineteenth Century and After"), E. L. Hirst ("The Chemistry of Vitamin C"), and A. P. Meiklejohn, C. P. Stewart and R. Passmore ("The Rôle of Ascorbic Acid in the Human Body"). Every worker on vitamins, and every medical historian, can now be proud to possess, on his own bookshelf, a copy of the famous Lind "Treatise".

It is sometimes said that Lind was the first to discover how scurvy could be cured or prevented, namely, by the use of orange or lemon juice. This is a slight, if pardonable, exaggeration. Others before Lind had, in fact, recorded how scurvy might be controlled by the consumption of such 'antiscorbutics' as a decoction of spruce pine needles (Jacques Cartier, 1535), or by oranges and lemons (Sir Richard Hawkins, 1593). Most notably, in 1601, Sir James Lancaster had introduced into the ships of the East India Company the regular use of oranges and lemons as a sure preventive of this dreaded scourge of mariners. Then, during the seventeenth and eighteenth centuries, many others repeatedly confirmed the fact that fresh fruits and vegetables were effective in curing or preventing scurvy (for example, Woodall, 1639, Kramer, 1733).

But, as with so many scientific discoveries, what had been discovered was later to be forgotten and had to be re-discovered. Knowledge generally grows little by little, by developing what is already known rather than by some spectacular, unpredicted leap into the unknown. Just as no one individual can claim to have been the first to discover the existence of vitamins or to recognize the nature of the vitamin-deficiency diseases, so the knowledge of how to prevent scurvy empirically by means of fresh fruits or vegetables, or other fresh foods, emerged little by little.

Perhaps the juster claim to make on Lind's behalf is that he was the first, or one of the first, to carry out an accurately controlled clinical test, to prove conclusively how scurvy could be cured. To say that is not to belittle Lind's fame, but perhaps to enhance it.

Lind's own account of his test has been more than once quoted before, but bears repetition:

"On the 20th May, 1747, I took twelve patients in the scurvy, on board the *Salisbury* at sea. Their cases were as similar as I could have them. . . . Two of these were ordered each a quart of cyder a-day. Two others took twenty-five gutts of *elixir vitriol* three times a-day. . . . Two others took two spoonsfuls of vinegar three times a-day upon an empty stomach. . . . Two of the worst . . . were put under a course of sea-water. . . . Two others had each two oranges and one lemon given them every day. . . . The two remaining patients, took the bigness of a nutmeg three times a-day, of an electuary recommended by an hospital surgeon. . . .

"The consequence was, that the most sudden and visible good effects were perceived from the use of the oranges and lemons; one of those who had taken them, being at the end of six days fit for duty. . . . The other was the best recovered of any in his condition; and being now deemed pretty well, was appointed nurse to the rest of the sick. . . ."

Elsewhere, he writes:

"Some persons cannot be brought to believe that a disease so fatal and dreadful can be prevented or cured by such easy means. They would have more faith in some elaborate composition dignified by the title of an antiscorbutic golden elixir or the like. . . . Facts are sufficient to convince the unprejudiced. It is no easy matter to root out old prejudices or overturn opinions which have acquired an establishment by time, custom and great authorities."

In Lind's own day it was rightly said that scurvy had done more to reduce the fighting strength of the Royal Navy than enemy action and shipwreck combined. Lind himself, venerated as the 'father of nautical medicine', was the medical director of the Naval Hospital at Haslar, near Portsmouth, during 1758–83. This was, and still is, the largest hospital ever built. In his time, one-quarter of all the patients in it were suffering from scurvy.

The havoc which had been wrought by the disease among navigators is apparent from records going back to the fifteenth and sixteenth centuries. For example, when in 1498 Vasco da Gama had sailed around the Cape of Good Hope, a hundred of his men had perished from scurvy, out of a crew of a hundred and sixty. In 1593, Admiral Sir Richard Hawkins mentioned that ten thousand seamen had

* Lind's Treatise on Scurvy. A Bicentenary Volume containing a reprint of the first edition of "A Treatise of the Scurvy by James Lind, M.D.", with Additional Notes. Edited by Dr. C. P. Stewart and Dr. Douglas Guthrie. Pp. xl+440+4 plates. (Edinburgh: At the University Press, 1953.) 45s. net.

died from scurvy within his own personal experience. On one occasion a Spanish galleon had been found adrift at sea, its entire crew dead from scurvy.

But for centuries scurvy was of common occurrence not only among seafarers and explorers and armies in the field but also among civilian populations in most regions of Northern Europe. The reason for this was that throughout the dark months of winter vegetables and fruits were unobtainable. The principal factors which led ultimately to the decline of scurvy were the introduction of the potato into Europe, and the development of modern methods of transport—and, in more recent times, to the growth of exact, scientific knowledge about the existence of, and the properties of, the anti-scurvy vitamin.

After Lind's time the puzzle of scurvy was to be unravelled in gradual stages, both on the practical and on the theoretical side. In 1772, Captain Cook's voyage around the world owed its success to the measures taken by the Admiralty to protect the sailors from scurvy. Captain Cook himself was awarded the Copley Medal of the Royal Society in 1776 for his account of how the disorder had been prevented on board his ship. In 1804, at the instigation of Sir Gilbert Blane, regulations were introduced into the British Navy enforcing the consumption of daily rations of lemon juice. In consequence, the incidence of scurvy at the Haslar Naval Hospital fell from 1,457 cases in 1780 to vanishing point by 1806.

Later, the unwarranted substitution of preserved lime juice (unhappily inactive) for the fresh lemon juice (a potent antiscorbutic) was to lead to misunderstandings and misfortunes. The disaster which befell Captain Scott's expedition to the South Pole in 1912 can be attributed largely to a failure to supply active antiscorbutic articles of food.

Then again, during the First World War, outbreaks of scurvy still occurred in Britain: fifty cases were reported at a poor-law infirmary in Glasgow, eighty-two cases in a prison camp in another part of Scotland, and sixteen cases at an infirmary in Newcastle. The cause was considered to be a national shortage of potatoes; but a failure to apply existing knowledge might as justly be blamed.

As late as the beginning of the present century, infantile scurvy was still rife among bottle-fed babies, as a result of the wide use of sterilized or boiled milk, or of farinaceous milk substitutes, in place of fresh milk. The modern infant welfare movement, with its insistence on the provision of antiscorbutic supplements, has changed all that. Nevertheless, in a recent survey at the Johns Hopkins Hospital in Baltimore, Maryland, U.S.A., microscopic evidence of scurvy was found to be present, *post mortem*, in 31 per cent of those babies examined, between the fifth and eleventh month of age, who had been fed on cows' milk alone.

Scientific, as distinct from empirical, knowledge about scurvy starts from 1907. In that year—following the earlier recognition that beriberi could be produced experimentally in birds, and was a disease of deficiency—Holst and Frölich, in Oslo, stumbled across experimental scurvy in guinea pigs, and they were quick to recognize it as another deficiency disease.

Writing in 1906, Hopkins had already referred to scurvy as a disease of which "for long years we have had knowledge of a dietetic factor", and he rightly added that the error in the diet was "still obscure" but "certainly of the kind which comprises the minimal qualitative factors". (And one recalls here, too, that as long previously as 1840 another far-sighted writer, G. Budd, had predicted that scurvy was due to the "lack of an essential element which it is hardly too sanguine to state will be discovered by organic chemistry or the experiments of physiologists in a not too distant future".) By 1912, Funk was able to postulate the existence of a distinctive anti-scurvy "vitamine", and to enumerate four separate disorders, namely, scurvy, beriberi, rickets and pellagra, as being "vitamine" deficiency diseases. In 1920, J. C. Drummond introduced the current alphabetical nomenclature, the letter "C" being reserved for the then unidentified anti-scurvy factor.

The earliest attempts to isolate vitamin C, by Zilva and by others, were rendered difficult by its instability and its power to undergo reversible oxidation. However, in 1928, the Hungarian biochemist, Szent-Györgyi, then working in Cambridge, isolated from the adrenal cortex, as well as from oranges and cabbage, a silver-reducing substance, first to be known as hexuronic acid. The suggestion was made by Harris in Cambridge, and by Tillmans and Hirsch in Germany, that this substance might, in fact, be identical with vitamin C. In 1932, when Waugh and King in the United States had at length succeeded in isolating an undoubted specimen of pure, crystalline vitamin C, they reported that it possessed all the properties of hexuronic acid; and almost simultaneously Svirbely and Szent-Györgyi in Hungary confirmed the antiscorbutic potency of hexuronic acid. The identity was not universally accepted at first; but tests soon proved that there was, in fact, an unfailing and quantitative correlation between the presence of hexuronic acid and antiscorbutic potency. Doubts were finally set at rest when the chemical structure was worked out, and the synthetic product was found to have identical activity with the substance isolated from natural sources. The vitamin was then renamed ascorbic acid.

Later advances have included, for example, the development of chemical methods for the estimation of vitamin C; and techniques have been devised for the assessment of vitamin C status in human subjects. Another point of interest is the recognition of the fact that the requirements for the vitamin are increased in infection. Among animal species, primates and guinea pigs are unique in needing vitamin C in their diet; all other animals, so far as is known, synthesize it in their bodies, the precursor apparently being glucose.

During the Second World War, the accumulated scientific knowledge on vitamin C which had so recently been won could be put to good service. Government action was taken to ensure an adequate supply of concentrated orange juice, or of black-currant juice, or synthetic ascorbic acid, for mothers and young children; encouragement was given to the cultivation by householders of fresh fruit and vegetables on 'allotments'; housewives were advised what measures should be taken to minimize losses on cooking; and procedures were worked out for manufacturing dehydrated vegetables, to be used, for example, in the desert campaign, which still retained their vitamin C. No outbreaks of scurvy were seen during the Second World War, in contrast with the conditions referred to above in the First World War, when outbreaks had occurred among the civilians in all the belligerent countries (including Great Britain and the United States), as well as among the armed forces at the various fronts, the total number of cases running into many thousands.

Little is yet known about the detailed physiology of vitamin C action, except that it is needed for the elaboration of the intercellular cementing substance, collagen, or, in a more general way, for the functional activity of the formative cells in general. Chemically, the vitamin is concerned in the conversion in the animal organism of folic acid (pteroylglutamic acid) into folinic acid, and in the metabolism of tyrosine. Vitamin C itself has intense reducing activity, but it has not yet been shown that its characteristic anti-scorbutic action can be attributed intrinsically to its redox properties.

Among various new points brought out at the Lind Bicentenary Conference, held in Edinburgh between May 22 and 23, was the suggestive fact, mentioned by C. G. King, that ascorbic acid may also have a role to take in the metabolism of cholesterol. At this meeting, contributions relating to vitamin C and allied topics were made by the following: Surgeon Vice-Admiral Sir Sheldon Dudley ("The Lind Oration"), Sir Edward Mellanby (opening remarks), Dame Harriette Chick ("Early Investigation of Scurvy and the Antiscorbutic Vitamin"), Dr. C. G. King ("The Discovery and Chemistry of Ascorbic Acid"), Dr. M. van Eekelen ("The Occurrence of Vitamin C in Foods"), Prof. H. A. Krebs ("The Sheffield Experiment"), Prof. S. B. Wolbach ("The Histology of Scurvy"), Prof. V. P. Sydenstricker ("The Impact of Vitamin Research on the Practice of Medicine"), Dr. J. H. Crandon ("Ascorbic Acid Deficiency in Human and Experimental Subjects"), Dr. R. M. Kark ("Ascorbic Acid in Relation to Scurvy, A.C.T.H. and Surgery"), Prof. E. J. Bigwood and Dr. J. P. Dustin ("Amino-aciduria in Infancy and Ascorbic Acid Deficiency"), Dr. C. P. Stewart ("Dehydroascorbic Acid in Human Blood Plasma"), Mr. A. J. Lorenz ("Pre-Lind Writers on Scurvy"), Dr. H. Gounelle and Dr. H. Teulon ("Contribution à l'étude de le Vitamine C dans certains états physiologiques et pathologiques chez l'homme"), Dr. W. J. Darby ("The Relationship of Ascorbic Acid to Tyrosine and to Hæmopoietic Vitamins"), Dr. L. W. Mapson and Dr. F. A. Isherwood ("Synthesis of Ascorbic Acid in Plants and Animals"), and Dr. Leslie J. Harris (chairman's summing-up). The proceedings are to be printed in full in a special, forthcoming issue of the *Proceedings of the Nutrition Society*. Obviously, anyone interested in the field of vitamins, whether from the separate aspects of biochemistry, physiology, dietetics or public health, will have need to consult this issue of the *Proceedings*. Together with the reprint of Lind's "Treatise", this record will form a fitting and permanent memorial to the pioneer whose memory was honoured at the bicentenary meeting.

## HIGH-FREQUENCY ELECTRICAL MEASUREMENTS

### CONFERENCE IN WASHINGTON, D.C.

THE third of the biennial conferences organized jointly by the American Institute of Electrical Engineers, the Institute of Radio Engineers and the National Bureau of Standards was held during January 14–16 in the Auditorium of the Interior Department in Washington, D.C. It was divided into four technical sessions dealing respectively with the measurement of frequency, length and time, power and attenuation, transmission and reception, and impedance. A list of the authors[1] and the briefest abstracts of the twenty-seven papers that were read would occupy the space of this article, and it will perhaps be preferable to select for more detailed treatment those subjects of particular interest to the writer.

Before the first session Dr. A. V. Astin gave a short address of welcome to the seven hundred delegates, and stressed the importance of the conference in helping specialists to keep abreast of this rapidly developing field of work. The chairman of the session, Dr. Harold Lyons, then introduced Dr. L. Essen, who described the frequency standards developed at the National Physical Laboratory, Teddington, their application to microwave measurements and, in particular, to the determination of the velocity of electromagnetic waves and the refractive indices of gases. The experiments involve the accurate measurement of both frequency and wave-length. Extensions of well-known techniques have given an accuracy of frequency measurement, throughout the radio-frequency spectrum, of one part in $10^8$, and microwave optics have been developed to give an accuracy of wave-length measurement of one part in $10^6$. Dr. Essen made use of a cavity resonator which is the microwave analogue of the Fabry–Pérot interferometer, while K. D. Froome used the analogue of the Michelson interferometer. The final accuracy that can be given for the value of the velocity of light, $c$, depends on the analysis and elimination of systematic errors due, in one case, to the imperfections of the surface of the resonator and, in the other, to the diffraction of the beam of radio waves at the transmitting horn and reflector. The values obtained are $299{,}792{\cdot}5 \pm 1{\cdot}0$ km./sec. and $299{,}792{\cdot}6 \pm 0{\cdot}7$ km./sec.

Dr. K. Bol then gave some previously unpublished details and the final result of the velocity determination initiated by Prof. W. W. Hansen at Stanford University. One of the main experimental difficulties had been the measurement of the length of the resonator, and this is probably mainly responsible for the spread of 2·2 km./sec. in the results. The final result of the measurements was given as $299{,}789 \pm 0{\cdot}5$ km./sec.

In view of the interest in the subject, a special discussion meeting was arranged by Dr. Lyons. The presence of so many of those concerned with the recent determination of the velocity of light would, he thought, afford a good opportunity for discussing the discrepancies between the various results, the question which is still sometimes raised of the variation of the velocity with time or frequency, and the best approach to a number of new measurements which are being planned. The result diverging most from the average of recent values is that obtained by D. H. Rank and his co-workers, from an examination of the infra-red and microwave spectra of hydrogen cyanide. Prof. Rank, although not at the meeting, had said earlier that there is some dissatisfaction with the wave-length measurements and that a new determination now in progress should give a considerably higher accuracy. In view of this and of some criticisms that were made about the way in which the final result is derived from the measurements, there was a general feeling that too much importance should not at present be attached to the discrepancy, although the method is one of great interest and potential importance.

The difference between the two cavity-resonator results was discussed at some length, but was not

satisfactorily explained. The technique employed at Stanford does not enable the effect of surface imperfections to be eliminated experimentally as it is in the work at the National Physical Laboratory, but Prof. E. L. Ginzton and Dr. Bol did not think that this effect could be large enough to account for a difference of 3 km./sec.

Commander C. I. Aslakson, who was responsible for the determination of the velocity of light by radar, thought that the precision could possibly be increased if the operators, drawn from the United States Air Force, were able to work on the project for a longer time once they had become skilled in the elaborate technique required to give a reliable result. J. E. R. Ross, of the Canadian Geodetic Survey, said that the average accuracy achieved in the use of radar for the rapid surveying of large tracts of land, the value of the velocity of light being assumed, was 5 parts in $10^6$. Dr. Essen expressed the view that if systematic errors had been assessed more carefully, all the results for the velocity would be in agreement within the experimental limits and that there is therefore no evidence to justify speculations concerning the variation of velocity with either time or frequency. The probable error of the work at the National Physical Laboratory is $\pm$ 1 km./sec., and further work now in progress is likely to reduce it to $\pm$ 0·3 km./sec. Any future work designed to improve our knowledge of the velocity of light should therefore aim at an accuracy of at least 0·3 km./sec.

The work on velocity afforded an interesting application of cavity resonators. The two following papers were concerned with their more general properties, G. L. Hall describing the analysis and measurement of their circuit parameters and A. E. Wilson the techniques adopted at the National Bureau of Standards, Washington, D.C., for their rapid and accurate calibration as wavemeters.

The remaining part of the session was occupied by three papers dealing with frequency standards and measurement. T. A. Pendleton described an investigation at the National Bureau of Standards on the use of quartz standards as resonators. Their frequencies were measured daily, and it was hoped that the drift would be less than that of similar quartz units maintained in continuous vibration. To secure constant operating conditions, some of the resonators were housed at the bottom of 60-ft. shafts where the temperature was stable to about $\pm$0·001 deg. C. A. S. Bagley gave details of a new equipment for the measurement of frequency and time interval which was based on the use of counting-circuits operating at a rate up to $10^7$/sec.; and finally W. E. Leavitt described an electronic chronograph readable to 0·02 msec. A further paper on frequency measurement was read at the last session. In this H. J. Finden gave an account of the extension of frequency synthesis and the production in a decade scale of standard frequencies up to 100 Mc./s. in steps of 1 kc./s.

At the next session, presided over by E. W. Houghton, there were three papers on power measurement and three on attenuation. In the first, M. S. Tanenbaum, dealing with the power that waveguide components can withstand without discharge breakdown, pointed out the need to express results on a statistical basis and suggested that the criterion of breakdown power should be that causing breakdown on 50 per cent of its applications. One of the difficulties of the tests at very high frequencies is the generation of the necessary power or voltage, and three ways of overcoming this have been used: a standing wave is produced in the guide to give voltage magnification; the dimensions in one direction of the guide are reduced; or the pressure is reduced by a known amount. From the results, the behaviour for normal conditions in the guide can be calculated. The lively discussion following this paper was evidence of the wide interest in breakdown problems. H. H. Grimm followed with a description of some pressurized, broad-band, water terminations used as calorimeters and concluded that the hairpin type, modified in order to reduce reflexions, gives the best performance, having a voltage standing-wave ratio of less than 1·03 for a power-level of 1·5 kW. and over a 5 per cent range of frequency. R. W. Lange explained some of the difficulties associated with bead thermistor power-meters. An instrument has been developed for 10 kMc./s. having full-scale sensitivities of from 4,000–40 $\mu$W. To achieve the accuracy required, it is necessary to select pairs of thermistors having not only the same characteristics but also similar ageing tendencies.

Attenuation measurements are based on the use of standard cut-off attenuators, and the precisely made microwave instrument described by R. W. Hedberg represents a useful contribution in this field. It employs the $TE_{01}$ mode in a rectangular guide, and the effects of mode purity and mode filtering were fully discussed. A resistance card attenuator of novel form was described by B. P. Hand. The card is oriented in the waveguide at a variable angle with respect to the plane of polarization and gives an attenuation range of from less than 1 db. to 50 db. It is suitable for high frequencies at which cut-off attenuators are impracticable without frequency correction.

Most of the papers read at the conference were short accounts of original work, and two demonstration lectures given between the second and third sessions allowed the delegates a little mental relaxation. In the first, A. G. Fox showed how, in the millimetre wave-length range, dielectric waveguides can be used for flexible patchcards and other circuit components. He then gave a simplified explanation of Faraday rotation in a ferrite medium, using a most ingenious model of a spinning electron. A uniform magnetic field was simulated to produce precession, and a rotating magnetic field to produce a change in the angle of this precession. In the second lecture R. L. Wallace demonstrated some of the properties of a new high-frequency transistor. It enables instruments such as lapel microphones and hearing-aids to be made very small in size, and the total bulk of the batteries required to operate them for a period of a year was shown to be only a small fraction of that required by present-day instruments. The audience was left in no doubt about the importance which the new transistor will have when it becomes generally available.

A basic requirement in all high-frequency measurement work is the provision of suitable sources of oscillation, and three papers read at the session on transmission and reception, at which J. W. Kearney was the chairman, were concerned with this problem. N. A. Spencer described a waveguide cavity designed for the external tuning of the *RK*-5721 reflex oscillator tube. The mechanical tuning by means of non-contact plungers and the voltage adjustments are operated by a single control, and a range of approximately 8–10 kMc./s. is obtained with a power output of approximately 50 mW. S. F. Kaisel gave details

of a new type of oscillator, which can be tuned, by varying the voltages on the electrodes, over a frequency range of more than one octave. He also gave a survey of the frequency-ranges and power-levels obtained at various laboratories. In the millimetre region the difficulties of generation become very much greater, and quite new principles may have to be employed. There was no paper at the conference dealing with such investigations, but C. W. Johnson showed what can be done with existing equipment. An oscillator in the region of 24,000 Mc./s. (1·25 cm.) is fed to a crystal diode, and by careful adjustment of the circuits a usable amount of power at harmonic frequencies up to the tenth can be obtained. The cartridge of the crystal diode, of type 1N31 for example, is slotted near the crystal and is then fitted in a waveguide assembly so that the slot is across the small guide, in which the harmonics are generated. In an alternative form the diode is dismantled, and the crystal and cat's-whisker are connected directly across the waveguide carrying the fundamental frequency. The power obtained at 100 kMc./s. (3 mm.) is 10 μW., which is adequate for many purposes.

Later in the session C. F. Edwards gave an account of some tests on microwave noise-generators, which indicate that, after an initial ageing period, the microwave noise-output of a fluorescent lamp is remarkably constant; for example, a lamp with a relative noise output of 15·75 db. changed by 0·5 db. in the first few hours, after which no further change was detectable.

F. J. Gaffney presided over the last session, at which a wide range of impedance-measuring equipment was described. In many instances a rapid inspection of the matching of a transmission system is required rather than an actual measurement of impedance, and a very useful equipment for such purposes was described by W. P. Peyser. The frequency range covered by two instruments is 100–1,350 Mc./s., and an oscilloscopic presentation of the variation of voltage standing-wave ratio with frequency is provided so that adjustments to the component under test can be made to give the best performance over the required range. A relatively inexpensive slotted line for the measurement of impedance and standing-wave ratios was described by C. F. Miller. The line is approximately three metres long, the central conductor being supported by a thick-walled 'Styrafoam' cylinder. Some of the problems encountered in the conversion from balanced to unbalanced systems were considered by O. M. Woodward, jun., and a device for measuring the efficiency of the transformers used was described.

For the comparison and measurement of impedance in the microwave region, bridge methods using hybrid junctions are likely to be increasingly important, and M. D. Adcock's description of a new type of junction was therefore particularly interesting. The symmetrical arms of a conventional junction, or magic *T*, are arranged to be contiguous and parallel to the *H*-plane arm. A voltage standing-wave ratio of less than 1·1 for all arms is obtained with an isolation greater than 50 db. between the *E*- and *H*-plane arms. These figures hold for a frequency-range of 12 per cent, and the method of construction makes the power-handling capacity of the junction as high as that of the corresponding waveguide. In another interesting paper G. Deschamps showed how impedance measurements can be made on non-conventional guides such as microstrip by using standard equipment and correcting for the junction discontinuity.

In addition to the technical sessions, visits were arranged to the National Bureau of Standards, the U.S. Naval Observatory, the Naval Ordnance Laboratory and the Naval Research Laboratory; and a luncheon was held at the Hotel Statler. The guest speaker at the luncheon, Dr. A. T. Waterman, gave an interesting account of the work of the National Science Foundation and expressed some concern that, under present conditions, it has been necessary to allocate a considerable proportion of the funds of the Foundation to applied science instead of to fundamental research.

The keenness of the delegates, the strict adherence to the time-table and the smooth working of the organizational arrangements were features of this successful conference, and were evidence of the preparatory work of the joint committee under the chairmanship of Mr. E. P. Felch. It is, incidentally, a pleasure to record that the committee acted as most hospitable hosts to the overseas delegates.

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L. Essen

[1] *Proc. Inst. Rad. Eng.*, **41**, 172, titles only (1953).

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# SOUNDS OF JETS

By Dr. E. G. Richardson

King's College (University of Durham), Newcastle upon Tyne

The vibration of jets of water or gas issuing into the atmosphere has been a favourite study in classical physics for more than a century. Plateau was one of the early students of this phenomenon, and in his treatise, "Theory of the Modifications experienced by Jets of Liquid issuing from Circular Orifices when exposed to the Influence of Vibratory Motions", he showed that a column of liquid subject to surface tension undergoes rhythmic changes of figure of the type named by Lord Rayleigh as 'varicose'. Later, it was shown that the jet under vibration could also pendulate from side to side, both types of oscillation eventually causing the jet to break up into drops. A kindred study of the early days was that of the sensitive flame, a favourite topic of Royal Institution Discourses given by Tyndall. Shorn of the unessential combustion, this comprises a jet issuing from a narrow orifice without capillarity forces—that is, of a liquid into liquid or of a gas into gas—which, though inherently unstable, could have its instability rhythmically controlled by a sound.

None of these jets however, except some varicose water jets, has any preferred frequency. For this, some form of resonance or interference is necessary. The earliest form that this took was to let an air jet impinge on a sharp wedge. Such 'edge tones' were first heard by Sondhauss; and later Wachsmuth, noticing the relationship between this phenomenon and the diapason organ pipe, took photographs of the jet, to which ether vapour had been added. He showed that, if the distance from slit to edge is kept constant, and air at low pressure admitted to the wind chest behind the slit, the pitch of the edge tone rises with efflux velocity (with some jumps of frequency at certain pressures), while if the wind pressure is kept constant and the wedge moved away

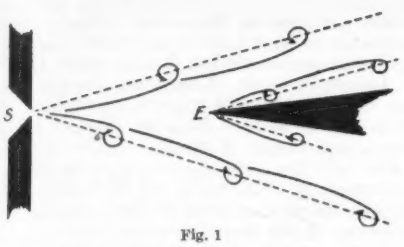


Fig. 1

from the slit, an opposite effect on the pitch occurs. When the well-known alternate vortex street behind an obstacle in a stream was set on a theoretical basis by von Kármán, a similar vortex system was invoked to explain what could be seen in an edge-tone jet, although it was recognized that the eddies do not emerge full-grown from the slit but gather strength as they are carried towards the edge.

About twenty years ago, two rival theories of the edge tone were current. One regarded the phenomenon as purely acoustic; each time a vortex hit the edge a sound wave signalled back to the edge to start another one. E. G. Richardson[1] thought that he had disposed of this theory by opening another jet alongside the principal one and showing that the postulated sound wave is unable to set this subsidiary jet into pendulation; but recently A. Powell[2] has revived this hypothesis. The second theory was a hydrodynamic one, based on an observation of Richardson that a secondary vortex system is set up in the boundary layer alongside the wedge, as shown in Fig. 1, and that these have to fall into line with the main system to form two vortex streets, one each side of the wedge. N. Curle[3] has recently taken up and extended this theory, showing that the hydrodynamic reaction on the fluid debouching from the slit results from the alternating transverse velocity at the tip, without the intervention of any sound signal. At low velocities, when the edge tone results from a simple periodic pendulation, it ought surely to be possible to give a purely hydrodynamic explanation to the phenomenon. It may be noted, indeed, that pendulations similar to those of edge tones may be produced when underwater jets strike an opposing wedge at speeds far too low to engender sound waves in the water[4].

Reverting to the unassisted jet (from a circular orifice), one may assume that the origin of the hissing noise which accompanies the efflux of air at moderate speeds is to be found in shearing forces, both within the nozzle and outside where a 'surface of discontinuity'—as Helmholtz called it—exists between the fast-moving and the more-or-less stationary air. Here boundary layers engendering turbulence are to be found, at first apparent as small eddies or high-frequency fluctuations; but farther down the jet these roll up into larger ones, involving fluctuations of lower frequency. Examination of the spectrum of turbulence with hot wires and of the associated sound spectrum with microphones show them to be closely parallel. (This has recently been shown in jets[5], but was earlier demonstrated in wind tunnels[6] and with respect to the sounds of natural turbulence in the open air[7].) At any rate, confirmation of the statement about the relative sizes of the jet eddies can be found when one traces back the sound picked-up from the microphone to its origins, the high-frequency sources then being revealed as located near the nozzle, while the low-frequency sources are to be found farther downstream and carried with the jet.

It is a matter of more than theoretical interest to determine what kind of sources are involved in jet systems, since this determines how and in what particular directions the sound will be radiated into the neighbourhood. W. L. Nyborg *et al.*[8] discovered maxima of intensity in directions at right-angles to the axis of a linear jet – edge system with minima in line of the jet, both behind and before. Thus, the polar curve corresponds to an acoustic dipole source ($p = p_0 \cos\theta$). At higher speeds the maxima for a circular jet (without edge) lie at 45° to the axis, corresponding to a set of acoustic quadrupoles. This is the basis of M. J. Lighthill's[9] theory for the (subsonic) jet in which he obtains an expression for the quadrupole field in terms of the second differential of the stress tensor $\rho uv$ (where $\rho$ is the density, $u$ and $v$ the component velocity fluctuations in perpendicular directions). This stress is also the basis of Reynolds's theory of turbulence and is known by his name. Having localized the sound intensity at places of large shearing forces, Lighthill then proceeds to map out the sound field and also to prove that the overall sound intensity will be proportional to the eighth power of the efflux velocity, showing how important this factor is for the production of noise.

These conclusions are fairly well supported by experiments on model jets. Such 'smoothing' of the polar curves for intensity in comparison with theory as is observed can probably be ascribed to the scattering of the sound as it passes through the turbulent field[7].

When the speed of efflux from the nozzle exceeds that of sound in the gas, a change in the disposition of the jet ensues. Schlieren photographs show that the jet alternately expands and contracts, while it is criss-crossed with a system of shock waves originating at the nozzle and reflected at the confines of the jet. The phenomenon is now acoustic rather than hydrodynamic in mechanism. One can, for example, let the jet—from a circular nozzle—impinge on a coaxial metal ring to produce edge tones of a definite frequency, but only if one places the round edge near one of the zones of instability at which the shock waves are reflected (Fig. 2). Presumably in this case there is resonance of the waves reflected from the ring with those set up at the nozzle, as suggested by Wachsmuth for the low-speed edge tone. The jet – edge system just described is, in fact, the basis of the Hartmann generator[10] in which, by constructing the apparatus on a miniature scale (nozzle about 0·5 mm. diameter, jet-edge separation about 1 mm.), this investigator was able to construct a source of ultrasonic frequency.

A jet of supersonic velocity is, in fact, an efficient converter of momentum into acoustic power, some of it audible, some ultrasonic. It has been suggested by E. J. Richards[11] that the origin of this excess noise (above that of a merely turbulent jet) arises from the interaction of the shock waves with the turbulent boundary layer or 'surface of discontinuity'. On this idea the zones of instability aforesaid will

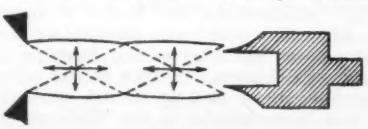

Fig. 2

become potent sources of sound. The sound field around the jet will then be rather like that of light in front of an optical grating—that is to say, there will be directions in which the energy from different sources will constructively and destructively interfere—and there is some experimental evidence, from polar curves of supersonic jets, which supports this. What is perhaps more important is that in this range of speeds the noise-level increases at a power of the jet velocity much higher than the eighth—perhaps, the twentieth or more.

This behaviour of jets at subsonic and supersonic speeds was described by Prof. E. J. Richards and G. M. Lilley at a symposium on "Aeronautical Acoustics, in particular Jet Noise", held in London on May 21 under the joint auspices of the Royal Aeronautical Society and the Acoustics Group of the Physical Society. Other speakers dealt with the noise of jets in gas-turbine engines (F. B. Greatrex) and the noise of jet aircraft (N. Fleming and J. D. Hayhurst). The bangs heard as an aircraft crosses the sound barrier were described by C. H. E. Warren, and these have been the subject of a recent article in *Nature*[12].

In the discussion which followed, speakers emphasized the nuisance which the starting and landing of aircraft constitute to those who live and work in the vicinity of aerodromes and the need for mitigation of the noise if aircraft travel at still higher speeds. Some of the speakers described tests of devices to reduce jet noise, but none of the reductions amounted to much in terms of decibels. A dilemma seems to have been reached in which the only cure for the noise is to reduce efflux velocity, but this means wider jets to maintain the thrust and so heavier engines, which could rob the gas turbine of one of its chief advantages.


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# OBITUARIES

## Sir Robert Archibald, C.M.G.

Robert George Archibald died suddenly on May 2 in Salisbury, Southern Rhodesia, at the age of seventy-three years. He was the son of the Rev. W. F. Archibald, chaplain to the Forces, and was educated at Dollar Academy and the University of Edinburgh, where he graduated in medicine in 1902. After holding various house appointments, he entered the Royal Army Medical Corps in 1906, and was a pathology prizeman in the Royal Army Medical College, where he worked with Sir William Leishman. In 1907 he was seconded to the Sleeping Sickness Commission in Uganda. In 1908 he was attached to the Egyptian Army and appointed assistant pathologist and bacteriologist in the Wellcome Tropical Research Laboratories, Khartoum, which was then a department of Gordon Memorial College. Here he was destined to spend the next twenty-eight years, years of memorable service during which the Wellcome Laboratories in Khartoum became world-famous as an institute of tropical research under the direction of Sir Andrew Balfour, later of Dr. A. J. Chalmers, and finally of Sir Robert Archibald himself. He held the post of director from 1920 until his retirement in 1936, when the Wellcome Tropical Research Laboratories were divided among various departments of the Sudan Government.

These were years of intense productive activity. Archibald contributed numerous papers to the Reports of the Wellcome Tropical Research Laboratories, and with Balfour he compiled the "Reviews of Recent Advances in Tropical Medicine", published as supplements to the Reports and continued as the *Tropical Diseases Bulletin* by the Bureau of Hygiene and Tropical Medicine in London. He was a contributor to the "Oxford Index of Therapeutics" (1921) and editor (with Byam) of the monumental treatise, in three volumes, on "The Practice of Medicine in the Tropics" (Oxford Medical Publications). Archibald's own researches during this period are scattered through the scientific and medical journals in innumerable articles covering almost every aspect of tropical medicine and hygiene. He was local secretary of the Royal Society of Tropical Medicine and Hygiene, president of the Sudan Branch of the British Medical Association, member of the executive committee of the British Empire Leprosy Relief Association and *membre correspondant* of the Société de Pathologie Exotique. He was one of the original members of the Council of the Kitchener School of Medicine and later a member of its executive committee in London. He was also a member of the executive committee of the University College of Khartoum.

During the period of his Sudan service, Sir Robert Archibald saw active service in the Blue Nile operations (1908), Mediterranean Expeditionary Force (Dardanelles, 1915), and in the Darfur expedition (1916). He was several times mentioned in dispatches; he was awarded the D.S.O. in 1917, C.M.G. in 1928 and created knight bachelor in 1934. He was awarded also the Order of the Nile (second class) and Order of the Mejidieh (fourth class). After his retirement from the Sudan, Sir Robert Archibald was for a time medical superintendent of the Chacachacare Leper Settlement, Trinidad, West Indies. Later, during the Second World War, he was pathologist, County Laboratory, Poole, Dorset, and for some years before his death he was professor of bacteriology and parasitology in the Farouk University, Alexandria, Egypt.

Although it is nearly twenty years since Sir Robert Archibald left the Sudan, he is still remembered here with deep affection and respect—the good physician, able investigator, wise administrator, kind teacher and great gentleman whose death symbolizes the passing of an era.

Robert Kirk

## Prof. D. Hanson

Prof. Daniel Hanson was born in 1892 and was educated at Wallasey Grammar School and at the University of Liverpool, where he took the degree of M.Sc. After a short time at the Research Department, Woolwich, he went in 1913 to the National Physical Laboratory as junior assistant (now called junior scientific officer) in the Metallurgy Division.

In 1914 the superintendent of the Division, Dr. W. Rosenhain, went on a world lecture tour, and while he was away the First World War broke out. The two senior members of the staff were called to the colours, and Hanson and one other were left to carry on the metallurgical side of the work.

Hanson rose to be senior scientific officer in the Department, and published some twenty-five to thirty papers, mainly on aluminium alloys, impurities in copper, and fatigue in metals. His early interest was in constitutional diagram work, as exemplified by the excellent series of papers which he published with Marie L. V. Gayler on various binary and ternary aluminium alloys, work which set a new standard of accuracy at that time and which has rarely, if ever, been surpassed since. While it is obvious that his interests covered a much wider field as time went on, the accurate determination of an equilibrium diagram was always a subject that attracted his attention.

In 1926 Hanson left the Laboratory to take up the post of professor of metallurgy in the University of Birmingham—a position which he held until his death on June 12. The department, which was quite small when he took it over, grew until in the last few years he was director of a department that had three professors besides himself in addition to a number of lecturers and research students. The buildings also were considerably enlarged, a special block being erected for the Industrial Metallurgy Section, and an extra floor being added to the main building.

The subjects which he had studied at the National Physical Laboratory still claimed Prof. Hanson's attention, but he added to them cast iron and tin alloys. In all he published about seventy papers in the *Journal of the Institute of Metals*, the *Journal of the Iron and Steel Institute*, and various other places.

Hanson established a reputation for himself, not only in Great Britain but also in many other parts of the world. He lectured in Australia, Canada, New Zealand, the United States and elsewhere. In particular, he gave the Institute of Metals Autumn Lecture in 1930, a British Exchange Paper at the International Foundry Convention meeting in Paris in 1932, and the eighteenth annual lecture to the American Institution of Mining and Metallurgy at its New York meeting in 1949. He also was a member of the delegation of British scientists that discussed, in 1950, the release of information on atomic research with American and Canadian scientists. He served for many years on the Council of the Institute of Metals, and was a vice-president from 1928 until 1939.

In spite of all his success in his professional life, Hanson had a complete absence of 'side'. He had very great charm and will be much missed by a large circle of friends.

J. L. HAUGHTON

# NEWS and VIEWS

## H. A. Lorentz (1853–1928)

A GREAT architect of the new era in physics and one of the most cosmopolitan men of science of all times, Hendrick Antoon Lorentz was born at Arnhem in Holland a century ago on July 18, 1853. He studied at the University of Leyden, where he graduated in philosophy in 1875, and became professor of theoretical physics at the early age of twenty-four. He was a voluminous writer, and his publications appeared in rapid succession over a period of more than fifty years in Dutch, French, English and German periodicals. His paper, "La théorie électromagnétique de Maxwell et son application aux corps mouvants" (1892), introduced and vindicated the conception of the electron in physics and supplemented Maxwell's theory on electromagnetic phenomena. His electronic theory of matter harmonized completely with the view which followed from J. J. Thomson's researches. Lorentz's expectation that a magnetic field would affect the appearance of spectra was realized in 1896 by his pupil, Pieter Zeeman, with whom he shared the Nobel Prize for Physics in 1902. The introduction of Lorentz's transformation revolutionized theoretical physics and became the foundation stone for the theory of relativity of another pupil of his, Albert Einstein. As early as 1880 he demonstrated the respective relations existing between the refraction of light and the density or aggregate condition, gaseous or fluid, of a translucent body. These relations were recognized independently and on different grounds by the Danish physicist, L. V. Lorenz, and are known to-day as the Lorentz–Lorenz relations. In Britain, Lord Rayleigh and Sir Oliver Lodge were chiefly responsible for making known Lorentz's work. Lorentz retired from the University chair in 1912, when he was appointed director of the Teyler Laboratory at Haarlem, and he died suddenly on February 4, 1928, at the age of seventy-four. Innumerable honours were showered on this simple, modest and likeable man, and, among British honours, he was elected a Foreign Member of the Royal Society in 1905 and received its Rumford Medal in 1908 and the Copley Medal in 1918. Besides his purely scientific work, Lorentz excelled at international gatherings, where his idiomatic command of languages and great personal charm won the respect and affection of men from all countries.

## Royal Society of Edinburgh: Honorary Members

THE following have been elected Honorary Fellows of the Royal Society of Edinburgh: *British:* Prof. Sydney Chapman, Department of Natural Philosophy, University of Oxford; Prof. A. C. Chibnall, lately Sir William Dunn professor of biochemistry, University of Cambridge; Dr. A. T. Doodson, director of the Liverpool Observatory and Tidal Institute, Birkenhead; Sir Harold Jeffreys, Plumian professor of astronomy, University of Cambridge. *Foreign:* Prof. C. P. H. Dam, Department of Biochemistry, Polytechnic Institute, Copenhagen; Dr. G. Egloff, director of research, Universal Oil Products Co., Chicago; Prof. K. M. G. Siegbahn, of Stockholm; Prof. O. Struve, Department of Astronomy, University of California.

## Funds for Colonial Welfare and Development

IN reply to a question in the House of Commons on June 24, the Secretary of State for the Colonies said that he hoped it would be possible to introduce legislation to provide further funds for Colonial development early in the 1954–55 session. Mean-

while, Colonial Governments could proceed on the assumption that the period in which the £140 million provided under the Colonial Development and Welfare Acts of 1945 and 1950 may be spent would be extended beyond March 31, 1956. Colonial Governments were also being informed that, where necessary for essential development, they may enter into commitments extending beyond 1956 and exceeding the £140 million already provided, up to a limit of £7 million, and subject to Treasury concurrence, on the understanding that in due course Parliament would be asked to vote the necessary moneys. Mr. Lyttelton also said that because of the serious world rice shortage, funds had been made available to a maximum of £3 million for promoting the production of rice in the Colonies. The special schemes for growing rice might ultimately involve expenditure exceeding the statutory limit, and such expenditure would be covered by the legislation already indicated.

## Commonwealth Bureau of Pastures and Field Crops

The Commonwealth Bureau of Pastures and Field Crops, which has been attached to the Welsh Plant Breeding Station, Aberystwyth, for the past twenty-four years, will be transferred to Hurley, Berkshire, in August, where it will be attached to the new Grassland Research Station, of which Dr. Wm. Davies is director. This Bureau, one of the ten Commonwealth Agricultural Bureaux, was founded at Aberystwyth in 1929, its first consultant director being Prof. (now Sir) George Stapledon. For the first twenty years of its existence the Bureau was in charge of Dr. R. O. Whyte, who was succeeded as director in 1949 by Mr. A. G. G. Hill, formerly director of the East African Agricultural Research Institute, Amani. The Bureau issues the quarterly abstract journals *Herbage Abstracts* and *Field Crop Abstracts*, in addition to its other activities.

## Conditions in the Rajputana Desert

A number of Indian authorities took part at New Delhi in a symposium on the Rajputana Desert, called formerly the Great Indian Desert. The lengthy papers have now been published in full (*Bull. Nat. Inst. Sci. of India*, No. 1, Sept. 1952). These are prefaced by a general review by the president, Dr. S. Lal Hora. The economic problem that gives this region great interest is the report that the desert is rapidly spreading and, furthermore, that the desert conditions are becoming intensified. These conditions may be due, if they do occur, to at least three causes: first, change of climate; second, drifting of sand to adjoining districts; and third, overgrazing on the confines, deforestation and wasteful methods of cultivation. The extent of the creep of desert conditions north and north-east has been estimated at more than half a mile a year, but this occurrence is not universally accepted, for it must be remembered that the Rajputana Desert is not a true hot and arid desert, since part of it gets enough rain to afford pasture at certain times. The atmospheric conditions are discussed in full in this monograph. Former better watered conditions are undeniable, as old water-courses and archæological remains show. One means of checking deterioration is to limit grazing on the edge and reafforestation so far as possible. A limited amount of grazing and cultivation is certainly possible in some parts and might be increased in good years, but decreased in dry conditions.

## Marine Biology in the Irish Sea

Most zoologists will welcome the fifty-eighth volume of the *Proceedings and Transactions of the Liverpool Biological Society* (vol. 58; pp. vi+109; 25*s*.). Over a long period of time under a changing editorship (the latest editors are Mr. J. S. Colman and Dr. J. W. Jones) this well-known series has published many notable contributions to marine biology. The present volume contains three papers which together add appreciably to our knowledge of the natural history of the Irish Sea. The first paper, by Dr. D. I. Williamson, describes the distribution in the Irish Sea of some important plankton species in relation to water movements. A point that emerges in comparison with earlier work is the stability, during the present century, of the composition of the plankton in the central Irish Sea. This contrasts markedly with the changes which have taken place in the plankton of the western English Channel during the same period. Dr. Williamson concludes that the Irish Sea plankton is less dependent on influxes of oceanic water than is that of other areas, and suggests that local regeneration in a relatively deep and stable water-mass overlying a muddy bottom helps to support the rich zooplankton characteristic of the area. The second paper, by Mr. A. B. Bowers, is concerned with the spawning grounds and the larval stages of herring in the same region. Manx herring spawn, in autumn, on rough ground a few miles east of the Isle of Man where two water-masses mix. One of these water-masses contains a *Sagitta elegans* community, the other a plankton characterized by *S. setosa*. The growth-rate of the Manx autumn-spawned herring is considerably less than that of spring-spawned herring in the Clyde. The final paper, by Dr. Sheila S. Meredith, is a study of the common shrimp, *Crangon vulgaris*, in the Dee estuary and in Morecambe Bay. Large quantities of this crustacean are caught annually for human consumption, but until recent years its biology has not been intensively examined. It is useful to have this account for comparison with similar recent work in the Severn estuary.

## Variation in the Lesser Celandine

In Great Britain, diploid and tetraploid races of *Ranunculus ficaria* often occur in the same population, the former being fertile, the latter highly sterile and multiplying largely by bulbils in the leaf axils. In Sweden it is the tetraploid—probably an autotetraploid—form of the species that is widely distributed, according to A. M. Perje (*Arkiv. för Botanik*, Stockholm, 2, Pt. 1–3, 251, 1952). This investigator has found that abnormalities occur in the formation of the pollen grains, though some fertile pollen is always produced. The embryo-sacs are normal up to the eight-nuclear stage, after which they usually begin to degenerate—a phenomenon which may be due either to heredity or to environment, or to a combination of both. Different clones show marked differences in the numbers of the several floral organs, an increase in stamen number being usually accompanied by an increase in the number of carpels. The observed variability is considered in terms of contemporary genetical theory.

## Information Theory

Information theory has a pretentious name, and has received a publicity almost comparable with that of relativity theory in the early twenties. Many scientists who have no time to read the original

papers and books by Shannon, by Norbert Wiener and by others, which make rather difficult reading for the non-mathematician, must have the uneasy feeling that they are missing something important. They will be much relieved if they read a short paper by Dr. P. M. Woodward, in the May issue of the *British Journal of Applied Physics*. There they will find that, so far as the non-specialist is concerned, the subject is one the essentials of which can be lucidly and comprehensively dealt with in a few pages. The paper will interest a very wide range of readers.

## Postgraduate Engineering Production Courses in the University of Birmingham

A NOTE on developments in engineering production and management studies, contributed by Prof. T. U. Matthew to the *University of Birmingham Gazette* (5, No. 4; 1953), refers to the increasing tendency of graduates in engineering to return to the University after four or five years in industry; and the Birmingham postgraduate diploma course of studies in the principles of engineering production management has been designed to meet the needs of such men who wish to fit themselves for the task of devising and introducing improved products and manufacturing methods, and for subsequent executive posts in production development or administration. During the past four years, fifty graduates have taken this course, and the current group of seventeen graduates includes five from overseas. The Department has also conducted short residential summer schools at Primrose Hill which have been attended during the past four years by more than a hundred and fifty senior managers and production engineers. The Department now plans to provide throughout the year a continuing series of short residential courses of the same nature, and the firm of Joseph Lucas, Ltd., has provided £57,400 for the purchase and equipment of a large house for use as a residential centre. Prof. Matthew believes that the University can play an important part in modern industrial society by providing educational courses and research facilities which bear directly on the problems of increasing industrial productivity and of strengthening the national economy. The major aim of the Department is to carry out scientific investigation on the main lines of study in the graduate courses, and this will be realized more fully when accommodation in the engineering buildings at Edgbaston becomes available next year. Meanwhile, grants from the Department of Scientific and Industrial Research and the Tube Investments Research Fellowship have greatly assisted research on work measurement and job evaluation, the variations in human muscular force, the output variation in repetitive tasks, the nature and acquisition of industrial skills, and the organization and use of scientific and technical information in Midland industries.

## International Commission on Illumination (C.I.E.): Meeting of Technical Committee on Daylight

AT the sessional conference of the International Commission on Illumination (C.I.E.) at Stockholm in 1951, it was agreed to hold a special meeting of the Technical Committee on Daylight in 1953 to discuss developments in the subject which were incomplete at the time. This meeting was held, during May 6–9, 1953, at the Abbaye de Royaumont, Creil, near Paris. Delegates from seven countries attended. The arrangements for the meeting were undertaken, on behalf of Australia which was unable to send a delegate, by the British delegation. Papers were presented describing recent work on the distribution of sky brightness, inter-reflexion of light in rooms, total solar radiation, and the systematic control of reflected sunlight in relation to building design in sunny climates. New instruments for the measurement of daylight factor, for the calculation of total daylight factor in rooms, and for the study of nebulosity were shown. An interesting feature of the conference was the apparently closer co-operation between physicist and architect in Britain, Australia and the United States than on the Continent. From the Continent come ingenuity and precision in the study of natural lighting, while the former countries are concentrating on practical applications of the work to building design and the development of simple tools and instruments for the wider use of architects and lighting engineers. The C.I.E. meeting was preceded by a conference organized by the Association Française des Eclairagistes, at which were read summaries of recent work in France, Britain, Sweden and Germany prepared by M. Jean Dourgnon, Dr. R. G. Hopkinson, Mr. Gunnar Pleijel and Prof. W. Arndt, respectively.

## Conference on Nuclear Physics

A CONFERENCE on nuclear physics is to be held in the University of Birmingham during July 13–18. Among the subjects to which sessions will be devoted are: low energy-levels and light nuclei; dense energy-levels and the statistical approach; study of the nucleus by high-energy processes; scattering of gamma-rays, angular correlations and conversion coefficients and oriented nuclei and polarized beams; experimental methods; and meson theory of nuclear forces. It is hoped to produce shortly after the Conference a set of notes, summarizing the discussions. About a hundred visitors from overseas and a similar number from universities in Great Britain are expected to be present.

## Salters' Institute of Industrial Chemistry: Awards

ON the recommendation of the director, Sir Alfred Egerton, the Court of the Salters' Company has elected the following to be Salters' Fellows for the year 1953–54: W. A. Holmes-Walker; P. P. Manning. Mr. Holmes-Walker has been demonstrator and assistant lecturer in chemistry in Queen's University, Belfast, and has carried out research on the electric and magnetic properties of alkyl-organic compounds; he proposes to carry out research in the Department of Chemical Engineering at the Imperial College of Science and Technology, London, on high-pressure techniques. Mr. Manning (Emmanuel College, Cambridge) has been carrying out research at Cambridge on the theory of molecular structure; he proposes to carry out research in experimental physical chemistry before entering chemical industry as a physical chemist. The Court of the Salters' Company has also elected the following to be Salters' Scholars for the year 1953–54: G. Hetherington, J. P. Howard, P. Kendrick, C. C. McCain and W. L. Wilkinson.

## British Memorial Fellowships, Victoria, Australia

BRITISH MEMORIAL FUND FELLOWSHIPS of the State of Victoria, Australia, have been awarded for 1953, as follows: *Agriculture*, Miss Mary D. Thomas (University of Wales); *Virology*, N. P. L. Wildy (Gonville and Caius College, Cambridge); *Natural Science*, Dr. Madeline C. Walters (University of

Birmingham); *Industrial Research*, R. M. McCleery (Magdalene College, Cambridge). Four other Fellowships in metallurgy, pre-school education and child development, arbitration (industrial), and British Commonwealth Studies, respectively, will be awarded next year. All the Fellowships, which are worth £A1,000, are for British subjects, less than thirty-five years old, with at least ten years of residence in the United Kingdom, and are designed to cover travel expenses to and from Melbourne and a stay of ten months in Victoria, commencing at the start of the academic year in March. Further details can be obtained from the Hon. Sir John Lienhop, Victoria House, Melbourne Place, Strand, London, W.C.2.

## Society for General Microbiology: Officers

The following have been appointed officers and committee of the Society for General Microbiology for the year 1953–54: *President*, Mr. H. J. Bunker; *Treasurer*, Dr. R. Lovell; *Meetings Secretary*, Dr. E. F. Gale; *General Secretary*, Dr. J. G. Davis; *Editors*, Prof. B. C. J. G. Knight and Mr. A. F. B. Standfast; *Committee*, Dr. P. W. Brian, Prof. W. Brown, Prof. K. E. Cooper, Dr. F. Fulton, Dr. Lillian Hawker, Dr. Betty Hobbs, Prof. J. W. Howie, Prof. J. W. McLeod, Dr. A. A. Miles, Mr. N. W. Pirie, Mr. H. Proom, Mr. G. Sykes, Dr. W. E. van Heyningen and Dr. R. E. O. Williams.

## University of London Appointments

The following appointments in the University of London have been announced: Dr. R. A. Shooter, senior lecturer in bacteriology in St. Bartholomew's Hospital Medical College, to the University readership in bacteriology tenable at that College. The title of professor of organic chemistry in the University has been conferred on Dr. D. H. R. Barton in respect of the post held by him at Birkbeck College, and that of reader in chemistry in the University on Dr. Allan Maccoll, in respect of the post held by him at University College.

## Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: P. A. Gething (agricultural officer, Federation of Malaya), senior agricultural officer, Federation of Malaya; A. P. S. Forbes (senior agricultural officer, Nyasaland), M. F. H. Selby (agricultural officer, Nyasaland), R. Smith (senior agricultural officer, Nyasaland) and H. V. T. Webb (agricultural officer, Nyasaland), chief agricultural officers, Nyasaland; J. H. Mackay (senior assistant conservator of forests, Nigeria), conservator of forests, Northern Rhodesia, Nigeria; A. C. Russell (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; A. Huddlestone (senior geologist, Gold Coast), deputy director, Geological Survey Department, Gold Coast; H. Service (deputy director of the Geological Survey, Federation of Malaya), director of the Geological Survey, Federation of Malaya; A. H. Milne (veterinary officer, Tanganyika), chief veterinary research officer, Tanganyika; J. B. Randall (deputy director of veterinary services, Uganda), director of veterinary services and animal husbandry, Uganda; L. U. Clarke (statistician, E. African Statistical Department), assistant director, E. African Statistical Department; H. J. Kitchener (game warden, Federation of Malaya), chief game warden, Federation of Malaya; R. G. H. Wilshaw (chief research officer, Agricultural Department, Federation of Malaya), chief registration officer, Federation of Malaya; H. Wright (drilling engineer, Geological Survey Department, Uganda), superintendent, rural water supplies, Geological Survey Department, Uganda; A. Gregor and D. A. Hutchings, veterinary officers, Northern Rhodesia; W. J. Herbert, veterinary officer, Nigeria; G. de G. Sieveking, curator, Department of Museums, Federation of Malaya; C. A. Smith, pasture research officer, Northern Rhodesia.

## The European Cortina–Ulisse Prize, 1953

The European Cortina–Ulisse Prize of a million lire is awarded annually by the international journal *Ulisse* for a scientific publication. For 1953, the Prize is being given in co-operation with the Italian National Productivity Centre, and will be awarded for a work on economic and social science dealing specifically with productivity. Only books printed for the first time in Europe during the past five years will be considered. Three copies may be submitted by author or publisher, and must reach the Editor, *Rivista Ulisse* (Sezione Premio Europeo Cortina–Ulisse), 43 Corso d'Italia, Rome, by October 31.

## "Library Co-operation in Great Britain"

Dr. H. T. Pledge, keeper of the Science Museum Library, writes: "Intending users of loan libraries may be misled by certain phrases on p. 1145 of *Nature* of June 27. It seems there to be implied that science loans are normally mediated by the National Central Library, so that a borrower's correct procedure is to apply to his local library. This, however, is only true of individual borrowers, for individuals cannot borrow direct from the Science Museum Library. Overwhelmingly the bulk of borrowing from this Library is corporate and is direct. The Regional–National Central Library system draws on a wider field, but, naturally, at the expense of promptitude. New research units should apply to the Science Museum Library direct, except for strictly medical literature, the best route for which is at present being re-examined".

## Announcements

Dr. Julian Huxley has been awarded the Kalinga Prize for distinguished popular writing in science. The Prize of one thousand pounds sterling was established in 1951 as a gift to Unesco from Mr. B. Patnaik, Indian industrialist. The first award, in 1952, was made to Prof. Louis de Broglie, of Paris.

The following appointments have been made in the Queen's University of Belfast: Dr. W. M. Gibson (University of Bristol) and Dr. E. B. Armstrong (Armagh Observatory), to lectureships in physics; Mr. D. M. McDowell (consulting engineer), to a lectureship in civil engineering (hydraulics).

The George E. Davis Memorial Lecture of the Institution of Chemical Engineers will be given by Mr. Norman Swindin in the Reynolds Hall, College of Technology, Manchester, on October 10. Mr. Swindin is a former pupil of George E. Davis, a pioneer in chemical engineering and author of the two-volume "Handbook of Chemical Engineering", published in 1901.

The Société Française de Métallurgie will hold its autumn meeting in Paris during October 19–23. The Society would welcome the participation of British metallurgists, and those interested are invited to write to the Société Française de Métallurgie, 25 rue de Clichy, Paris 9e.

# ELECTRON OPTICS

## SYMPOSIUM IN LONDON

A SYMPOSIUM on "Recent Research in Electron Optics", arranged by the Physical Society, was held during May 15–16 in South Kensington, London, in the Science Museum and in the Physics Department of the Imperial College of Science and Technology. About a hundred and fifty people attended. Of the twenty-two talks delivered, nine were concerned with pure electron optics, and the rest were devoted to a great variety of applications. Nuclear physicists learned about new developments in the design of accelerators and of β-ray spectrometers; electron physicists heard about measurements of quantum losses, scattering experiments, examination of luminescent semi-conductors and plasma oscillations in electron beams. Other talks were concerned with electron microscopy, X-ray production, and applications of electron optics in television and in valve design.

The meeting was opened with a short welcome of the visitors by Prof. R. Whiddington, the president of the Society, and by Dr. O. Klemperer, who had arranged the programme. The first four talks were on electron lenses. G. Liebmann[1] showed that very general practical formulæ can be given for presenting such properties as focal lengths, field distribution, errors, etc., of shielded lenses as functions of the magnetic gap-length, the diameter of the pole pieces and the excitation of the lens. Measured results deviate from these formulæ only when the saturation of the iron becomes substantial. Incipient saturation results in a loss of m.m.f., and at the pole-piece tips it has the effect of an apparent increase in lens dimensions. T. Mulvey[2] discussed the design of the magnetic circuit as the only efficient means of minimizing these saturation effects.

J. Ellis showed pictures and diagrams explaining the design of a large magnetic lens which is used in University College, London, for concentrating fast electrons or positrons from weak sources on to thin foils in order to study differences in scattering of these two kinds of elementary particles.

O. Klemperer[3] directed attention to the importance of line-focus lenses which project parallel rays into a focal line. The practical termination of 'two-dimensional' electrodes without introducing lens errors was mentioned as one of the practical problems. Results of measurements were given for the electrostatic plate lenses, box lenses and lipped lenses, and for the magnetic plate lenses, two-pole and four-pole lenses. Applications of line-focus lenses in a spectrometer, in an electron microscope and in a strong-focusing accelerator were shown in slides.

The following talks dealt with the corrections of aberrations. J. C. Burfoot[4] reported results of his theoretical studies on the possibilities of a correction of electrostatic lenses by abandoning rotational symmetry. He showed pictures of many queer equipotential surfaces which could produce foci without spherical aberration; none of these, however, could easily be applied to the design of practical lens electrodes. G. D. Archard discussed various possibilities of deviations from circular symmetry, leading to astigmatic foci. He demonstrated by means of a large plaster model the classifications of elliptical distortions and of corrugations of the end faces of electrodes or of pole pieces, and he explained the different kinds of magnetic and electrostatic 'stigmator' devices which have been used successfully in electron microscopy for the correction of this asymmetry error. J. E. C. Jennings remarked that every solenoid, even under conditions of best possible circular symmetry, would produce (probably due to the helical nature of the coil) an astigmatic focus. On the other hand, line-focus lenses can easily be obtained by winding the solenoid on to an asymmetric former—for example, of rectangular cross-section.

B. J. Mayo was concerned with the image curvature of electrostatic immersion lenses. Though, theoretically, a completely flat image field cannot be obtained with such lenses, some progress with the reduction of the curvature has been achieved by using first an accelerating lens for converging the pencils towards the axis and then a decelerating lens for focusing the pencils on to the image surface.

In the next section, devoted to the electron gun, M. E. Haine[5] reported his experiments with P. A. Einstein on a three-electrode, high-voltage emission system with a hairpin cathode. Maximum intensities of $10^9$ amp./m.$^2$ per unit solid angle have been obtained under optimum operating conditions for beams of a Gaussian angular current distribution. For high-beam currents at reduced bias, hollow beams were observed, the formation of which was derived from a marginal emission of electrons with outward radial velocity components running into a strongly converging field deflecting them across the axis. L. Jacob[6] spoke about the emission characteristics of low-energy guns with oxide cathodes. Maxima and minima in the angular distribution of beam current density were thought to be caused by plasma oscillations.

The following two talks dealt with the focusing in accelerators. F. K. Goward gave some information about the strong-focusing synchrotron project. The scheme is essentially based on an alternation of magnetic guide fields of very large positive and negative field index ($n$) in successive sectors of the orbit. However, the very high $n$-values and a correspondingly very large orbital radius, as visualized by Livingstone, the originator of the scheme, cannot be realized in practical machines owing to correspondingly minute tolerances for machining and alignment of the pole-pieces[7]; the projected machine has to be built on a more modest scale than was hoped for originally. J. S. Bell[8] discussed the application of the strong-focusing principle to the design of a linear proton accelerator, and recommended the use of electrostatic four-pole lenses which can be operated at relatively modest voltages.

In the following section on electron optics in television tubes and valves, L. S. Allard discussed the requirements for, and the limitations of, electrostatic and magnetic deflectors, especially in connexion with problems introduced by wide-angle scanning. He demonstrated a cathode-ray tube containing a fluorescent screen arranged tangentially to the deflected beam so that the defocusing effects introduced by the deflector could be seen at large deflexion angles. B. Meltzer spoke about certain time-lag phenomena which are most troublesome in the pick-up of rapidly changing scenes by television

cameras. These are due to the fact that a mosaic element on the signal plate is not discharged at once after cessation of the illumination, but only after several consecutive scans. The signal lag is found to be the shorter the larger the scanning current that can be concentrated upon the element; hence the limits to the reduction of the lag are set by electron optical conditions. The quality of the focus is known to deteriorate with increasing temperature of the electron beam. Apparently, owing to space-charge interaction, the beam temperature has been found to be much higher and to increase much more rapidly than the temperature of the cathode. C. S. Bull reviewed some applications of electron optics to valves: for example, the focusing by valve grids and the effects of an alignment of these grids. He also discussed the design of thermionic multiplier valves and of counting tubes[9], and he reported some recent attempts to increase the slope in deflexion valves with the help of space charge[10].

In the next section, G. W. Jull described his experiments with a velocity spectrograph with helical axis originally designed by D. Gabor, in which focusing deflexion is effected between cylindrical condenser plates; a change of 1 volt can still be detected at an electron energy of 1 keV. The use of this spectrometer was illustrated by experimental curves showing the small quantum losses which are known to occur at the transmission of electrons through thin foils. R. E. Siday discussed the accuracy of his absolute method for measuring β-ray energies[11], a method which depends on recording the angular rotation of a line image by a solenoidal field of exactly known magnetic potential difference. J. E. C. Jennings[12] gave a short survey of his theoretical and experimental investigations on the deflexion focusing errors of circular magnetic prisms.

Then followed two talks on fine electron foci. V. E. Cosslett[13] discussed the ultimate limits of obtainable current density ($> 10^7$ amp./m.$^2$) when these foci are scaled down to smallest diameters ($< 1$ micron) by the best available lenses at the greatest possible emission density from a hairpin cathode. These minute foci were shown to be very useful for producing sharp and intense shadow images in the electron point-projector or in the X-ray shadow microscope. W. Ehrenberg explained the use of these fine-electron probes for the investigation of semi-conductors. He showed photographs taken through a microscope from which the depth of penetration of the electrons into a fluorescent transparent solid could be gauged.

J. W. Menter[14] reviewed recent progress of the direct electron optical method for examination of solid surfaces. An electron beam of 50–100 keV. reflected at an angle of a few degrees from a specimen passes through the objective and projector lens of a highly magnifying electron microscope. Maximum intensity of reflexion occurs apparently at the glancing angle. The reflected beam consists of inelastically scattered electrons which have suffered losses of the order of 100 eV. Slides of excellent microscope photographs were shown in which the resolution in some cases reached about 100 A.

G. Liebmann showed slides and explained the design of the large resistor-network analogue which he has built up in the laboratories of Associated Electrical Industries at Aldermaston. This network is being used now to a great extent for solving electron optical problems—for example, for the determination of field distributions in electrostatic and magnetic lenses, especially when these are loaded by space charge.

Finally, P. A. Sturrock, speaking on some prevalent misconceptions in electron optics, directed attention to the confusion which surrounds some formulæ for focal length of electrostatic lenses. He also discussed the necessity for a clear distinction between dispersion and chromatic aberration of systems with curvilinear axis such as the semi-circular deflexion spectrometer.

Many of the items in this meeting were already known to the experts in the particular subject. However, the contents of the talks were always concerned with very recent developments—often still of controversial nature. For this reason the discussion was vivid throughout, and it was not difficult to establish contact between workers in widely diverging fields who were all joined by a common interest in electron optics.

O. Klemperer


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## THE SCIENTIST'S RESPONSIBILITIES*

By Dr. R. L. M. Synge, F.R.S.

It is fashionable among critics and broadcasters nowadays to speak patronizingly and almost contemptuously of the great rationalists of the nineteenth century—one thinks first of T. H. Huxley—who believed that the advance of our understanding of Nature opened to mankind a great prospect of material and ethical improvement. It is maintained that this was a delusion, and more compromising views about the nature and function of science are aired. The critics have not noticed that the intellectual giants, who were at work during the nineteenth century in the most advanced country in the world, have only in recent years achieved world-wide recognition. They believed that human troubles were to be overcome by human ingenuity rather than endured while blaming or accepting the 'will of God'. Just because here in Britain we have not achieved progress commensurate with what these prophets expected, we fail to see what a revolution there has been in the attitude of the millions of the depressed peoples of the world, and that it is to a great extent their unwillingness to go on accepting fatalistically their various troubles that has had effects on our own economic position and self-assurance. The change in the terms of our trade, consequent on a greater inclination by other nations to industrialize themselves and to eat more of the food they produce themselves, is for us the long-term background of

* Substance of an address given at the National Conference of "Science for Peace" in London on March 14.

the past fifty years; against this background we have two ruinous wars, the slump of the 1930's and the war preparations and threat of war of the present years.

The marvellous developments of science and technology during this same fifty years have not brought to us the benefits people were justified in expecting; benefits there have been, all the same, and it is typical of our nature to under-estimate them. But the main applications of the advances in pure science have been towards the technology of war, and this has been the most striking in the most recent years. Before the Second World War the application of science suffered from neglect; during and since the War, the official attitude changed—governments had at last learnt something of the power of applied science, and now to a great extent they are directing it towards objects that at best are unproductive and wasteful and at worst could bring about destruction on an unprecedented scale. On the surface at least, cynicism about the role of science has some justification.

The scientists themselves must bear some of the blame for the prevalent attitude. The detailed solving of *any* scientific problem is an absorbing pursuit, and it is very easy to bury oneself in the minutiæ of scientific research and not see the wood for the trees. It is widely maintained that "the scientist establishes facts: other sections of society make what use of them they will, and that use is to a great extent unpredictable". I think this is a serious under-estimate of the scientist's vocation. Admittedly he works within the framework of objectively ascertained facts, and admittedly there is a big element of unpredictability in the implications of any new discovery. But Nature is so complicated and manifold that those aspects or facts that a generation's work can hope to reveal are only a minute proportion of what is waiting there for future generations. Some of the spectacular advances of recent years have induced a sort of intellectual arrogance among scientists, an over-estimation of the extent of our understanding of Nature which leads them to under-estimate the enormous choice of pathways of experimentation and observation which lies open to us. This leads to a very routine approach to experimentation, and one which is much subject to crazes. Some fields of study are worked to exhaustion and others are neglected. The desire of those who finance research for immediate practical results is only partly to blame for this. Scientists must come to feel much more responsibility for *what* facts are ascertained, that is, for the direction taken by the progress of science. I will return later to some consequences of this for British science in particular.

The other stock answer of the scientist wishing to evade responsibility is "As a scientist . . . I have no more right than any other citizen to a special say in how public affairs are run". This often means "I am willing to be as dumb as other citizens while public affairs are mismanaged, even when it concerns matters of which I have special knowledge". Actually, of course, very serious pressures exist which prevent public comment by many of those best able to judge (for example, Civil servants) when affairs are being grossly mismanaged. One wonders how many appropriations of public funds comparable to the groundnut scheme are kept dark as a result of the Official Secrets Act or of the fear of loss of employment. I am far from claiming as desirable the substitution of politicians by scientists; but I do think scientists should be far more vocal than they are about matters of public interest where they have special knowledge. These are many and important. In work of this kind the different organizations of scientists can do great things, and this includes Science for Peace. I would like to congratulate the Committee on what it has done so far in getting important information and issues publicly dealt with.

The main problem which now faces us is the threat of war and the use in war of weapons having a new order of destructiveness. The problems raised by these new possibilities of waging war have been discussed at length by all manner of people. The bulletin of Science for Peace[1] has contained recently quite a lot of discussion of the "justification" for the use of one kind of weapon or another and of the ethics of scientists working on the elaboration of such weapons. My own view is that this sort of argument is rather sterile and not particularly helpful in the present situation. I maintain that many of the weapons the use of which is contemplated would have effects that are entirely unpredictable, and that whoever might be concerned with using them would be faced with charges not only of inhumanity but also of jeopardizing the future of the human race for generations to come. The greatest danger seems to come from radioactive substances and from ionizing radiations. But I do feel that the most important activity for us here and now is to work to put a stop to existing wars and to prevent future wars by agreement between the nations. That is why I support the British Peace Committee and, through it, the work of the world peace movement. The Press of Great Britain indulges in abuse of this movement, but is particularly careful not to mention its programme. This is the minimal programme I have just mentioned, and, being minimal, it obtains maximal support among all the nations of the world. It aims at the negotiation of a pact between the nations which will effectively prevent the use of war for the settlement of questions at issue. The very destructiveness and inefficiency of war for settling questions at dispute is more than ever manifest to the peoples of the world, and they are increasingly impatient with the present poker game of war preparation which is an oppressive burden to most people and likewise settles nothing. A genuine settlement could lead to satisfactorily controlled disarmament all round and to an effective control and accounting of radioactive materials. I cannot feel that after such a settlement the risk from biological warfare, the materials of which are admittedly difficult to control, would be a very great one. Such an international settlement is particularly important for Britain; in view of our high population density and our dependence on foreign trade we would be far more than averagely vulnerable in the event of full-scale war. Quite apart from its crippling effect on our economy, the contribution of successive British governments to the poker game by going in for constructing atom bombs is pathetic from this point of view.

Of course, I know that the preparation of expensive armaments is advantageous to various individuals, and also that should it cease the economy of the United States would be faced with serious problems of readjustment. But this is not sufficient to justify what is a serious economic burden carrying with it a still more serious threat for nearly every nation in the world.

This seems to me to be the immediate objective to work for, since if it can be attained the other secondary troubles which affect the scientist will in large measure fall away. These troubles, refusals of passports and visas, secrecy of scientific work, lack of freedom to publish (with its bad consequences for the individual trying to change his job), are things that really hurt scientists. We have a big job to do upholding the decencies of our profession and trying in all ways open to us to maintain the international unity of science against those influences that are trying to stifle it. But I think it is an illusion to suppose that ours is more than a delaying action; a delaying action which only makes sense on the supposition of an end by international agreement to the war preparations.

My own view about improving international relations and opening the way towards such an agreement is that the best hope lies in recognizing how firmly nationalist feeling is entrenched in the world to-day. My travels have extended only from the Alps to the Arctic Ocean and from Poland to Ireland, but even within that narrow compass there is plenty of nationalism, and it does not seem to be associated with any particular system of government or religion. To advocate a balanced national economy and truly reciprocal trading relations with other nations is not an inspiring doctrine compared with ambitious schemes for world or continental federation, international plans for reconstruction, and so forth. But I cannot help feeling that it is the path for true internationalism at the present time, and that these more grandiose proposals are very often suspect as projects for veiled interference by foreigners in a nation's own affairs. In particular, I think it is highly indiscreet for citizens of Britain to preach to other nations, particularly Asiatic nations, the neo-Malthusianism that has recently become so fashionable. Two members of the Committee of Science for Peace, F. le Gros Clark and N. W. Pirie, have done an excellent job in bringing together a number of gifted authorities on food[2] to show that these are problems for the coming two generations. It is for us to ensure their survival in an undamaged world. With them, we can all express our gratitude to Lord Boyd Orr for his evangelism for food and his respect for humanity all over the world.

While working towards really effective international agreement, we could well take steps to put our own national affairs in order. It has not been convincingly shown that even under existing conditions a smaller military expenditure could not be used to ensure more effectively our national security. At the same time, tensions due to the presence of our forces in the territory of other nations could be relaxed. We could also assert our sovereignty in our external trade, make suitable long-term trade agreements and keep them scrupulously. Such measures would permit at least the beginning of a departure from being chronically on the brink of bankruptcy, as well as contributing substantially to a diminution of international tension. We could then set about some of the jobs that are crying out to be done. Foremost of these is to stop cutting the education of our children. Of all the various forms of pound-foolishness in which we are involved at the moment this seems to me the one that will have the worst results in the long run. But we could also make a start on the long overdue improvements in most of our industrial capital equipment, and particularly in our use of fuel. Agriculture could also absorb a lot of capital with advantage. Once a government could show that it had some faith in the future, stemmed the inflation and produced a standard of living that rose rather than fell, plenty of people would be ready to put savings into productive projects of this kind. So far as scientists are concerned we have at this moment, with our tradition of all-sided fundamental science, a magnificent basis for developing those newer branches of technology that will be needed. New branches of pure science will also need cultivation. We have rather a good reserve of trained people who could do with wider scope for their abilities. We might even have a few over for helping other nations should they ask for such help.

Very few of the matters I have been discussing concern scientists alone. But progress on all of them would be more rapid if scientists were more upstanding and vocal about them; if, in fact, they took a more serious view of their responsibilities.

[1] Science for Peace, 49 Flower Lane, London, N.W.7.
[2] "Four Thousand Million Mouths", ed. F. le Gros Clark and N. W. Pirie (Oxford University Press).

## RESEARCH DEVELOPMENT IN THE MACHINE-TOOL INDUSTRY OF THE U.S.S.R.

In an editorial in the Russian machine and tool journal, *Stanki i Instr.* (**24** (1), 1; 1953), which is the official organ of the U.S.S.R. Ministry of Machine Construction, a directive is quoted of the nineteenth Session of the All Union Party on the progress of the current five-year plan (1951–55) as follows: "[Among our immediate objectives are] to improve the work of the scientific research institutes and the scientific labours of the highest scholastic establishments; make fuller use of the powers of science to solve fundamental questions in development of the national economy; make more generally available the most advanced engineering practice; and ensure wider practical use of scientific discoveries; moreover, to assist in every way the teaching profession to work out their theoretical problems in all branches of knowledge, and to strengthen the union of science with industry".

In the report on the work of the Central Committee of the Communist Party of the Soviet Union (VKP), Mr. Malenkov is quoted as emphasizing that, in the struggle for further technical progress, science must play a much greater part. Only thus will the Soviet people more fully discover and better utilize the great wealth and powerful forces of Nature. Much success has been already achieved in recent years of the greatest importance in the Soviet economy. At the same time, he revealed also certain defects and weaknesses. Incidentally, it may be observed that, at the eighteenth Session of the Party, Malenkov had a great deal to say by way of censure for slackness and bad management in certain branches of industry (quoted in a recent issue of the journal of the glass and ceramic industry, *Steklo i Keramika*).

The editorial proceeds to exemplify this closer union of research and industry by a brief review of the work of the various institutes associated with the Ministry of Machine Construction. Among these are: the Experimental Scientific Research Institute for Metal-cutting Machines (ENIMS), the Scientific

Research Institute for Tools (VNII), and the Scientific Research Institute for Abrasives and Grinding (VNIIASH). The relevant branches of manufacture receive regularly from these and other establishments information and examples of products and processes whereby labour efficiency can be raised, metal-working and the like improved, etc. Special attention is given to mechanization and automatization of methods. In addition to the three technical institutes mentioned, there is also a fourth which appears to fulfil the functions of a standardizing office, this being the Bureau of Interchangeability (BV). A great part of the work of all is concerned with components for electric motors and for the automobile and tractor industries, with formulating the best types of mass-production lines and working cycles, and in developing new machines and methods generally.

More specifically, the Abrasives and Grinding Institute has established the conditions for producing abrasive particles of given qualities and characteristics whereby grinding and polishing can be much more accurately controlled than was hitherto possible. Further details of its work were given in a report on the Russian abrasives industry (*Stanki i Instr.*, **23** (12), 6; December 1952). Reference is made to a large number of different types of new machines, tools and instruments, supplied to various factories in 1951 and 1952, including some woodworking and foundry equipment by the respective institutes for these two branches of industry. Details with drawings of some of these were published in *Stanki i Instr.* during 1952.

Yet it is complained that the introduction of new methods and improved equipment proceeds much too slowly, at all events in some of the engineering works, and there is considerable room for speeding-up and more efficient management in this direction. The same criticism has been noted in other industries—for example, in some of the glass and ceramic factories—according to the official journal for these. As has been stated above, it was voiced by Malenkov at the eighteenth Session of the Party in 1951. For example, some of the comparatively new designs from the metal-cutting machines institute, evolved five or six years ago, for high-efficiency worm-gear modular milling machines, permitting rates of feed two or three times greater than hitherto, have only very tardily been adopted ("become familiar") in general practice. More particularly in the machine construction works, the results of research, including new and improved types of high-efficiency gear-cutting machines, undertaken by the tool research institute and the Novo-Kramatorsk heavy machine-tool factory of the Ministry, have been practically ignored.

The improved ceramic-tipped or -faced cutting-tools designed by the abrasives institute, more especially those with thermo-corundum tips, should be much more widely adopted. These tools can replace those of high-speed steel and hard metals very often to great advantage both in high finish and semi-finish work, and thus ensure considerable economy in tungsten, titanium, cobalt and other materials in short supply. The real fault sometimes may lie with the institute concerned and its associate works, for, although it appears a little ambiguous, the statement is made to the effect that the abrasives institute, for example, together with the principal abrasive factory (Glavabraziva), produce totally inadequate supplies of high-speed grinding wheels (this, of course, may be partly due to lack of demand), and the metal-cutting machines institute is also charged with slackness in production.

It is suggested that, for speeding-up the more general adoption of better methods and equipment, the institutes concerned must maintain closer liaison with the factories, from the very beginning of their research along any particular line. This should be to the mutual advantage of both sides. More especially the workers themselves in the factories should be interested in, and attracted to, new developments. (Incidentally, it may be mentioned that one means of doing this in the machine-tool industry, to which reference is made from time to time in the technical press, is the organization of prize competitions for improved machine designs, although these may be limited mainly to the higher ranks of foremen, managers and draughtsmen.)

The scientific research establishments are directed to make wider use of possibilities suggested to them in the instructions and directives issued by the Ministry of Machine Construction. These directives apply also to the factories, and charge them with definite responsibilities in regard to the introduction of results obtained in the research institutes. It is a binding obligation on every worker, both in the institutes and in the factories, to make the fullest use of such results, described as the most powerful aid towards further engineering progress.

W. G. Cass

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# TRANSFERASE ACTIVITY OF HYDROLYTIC ENZYMES

By Dr. R. K. Morton

School of Biochemistry, University of Cambridge*

In recent years there have been a number of experimental demonstrations that certain preparations of hydrolytic enzymes may catalyse the formation of new compounds by transfer of a group from a 'donor' compound to a suitable 'acceptor'. While this 'transferase' activity was found to be associated with certain preparations of β-glycosidases[1], proteinases[2], and acid[3,4] and alkaline[5] phosphatases, the relationship between the enzymes catalysing hydrolysis and transfer was by no means clear. The exchange reaction has been ascribed to the combined action of two enzymes[1], to specific transferring enzymes[4] and to the hydrolases themselves[2,3,5]. A detailed study of the action of highly purified alkaline phosphatase has therefore been carried out in this laboratory. The results, which are summarized in this article, indicate the probable mechanism of the exchange reactions. They have been briefly reported elsewhere[6].

## Transfer Reactions catalysed by Alkaline Phosphatase

The alkaline phosphatases of both cow's milk and calf intestinal mucosa were purified to obtain essentially electrophoretically homogeneous proteins, using procedures already briefly described in *Nature*[7]. Synthetic creatine phosphate, glucose, magnesium acetate, and veronal buffer were incubated with the purified enzyme at *p*H 9·6 and at 37° C. for 2–5 min.

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Inorganic phosphate and creatine liberated were determined colorimetrically[8,9] and hexose phosphates were estimated enzymically[10]. The products were creatine, inorganic phosphate and glucose-6-phosphate only. Under the reaction conditions used, which were designed to measure true initial velocities, there was no detectable hydrolysis of the ester phosphate formed by transfer.

The initial experiments clearly established that both milk and intestinal phosphatases catalysed two reactions simultaneously :

creatine phosphate + water → inorganic phosphate + creatine (*A*)

creatine phosphate + glucose → glucose-6-phosphate + creatine (*B*)

When creatine phosphate was replaced by inorganic phosphate at the same (or at lower) concentrations, but with other conditions unchanged, there was no synthesis of glucose phosphate. Moreover, the addition of inorganic phosphate to the reaction mixture containing creatine phosphate appreciably inhibited both the hydrolytic and the transferase activities. Under the conditions employed, therefore, all new ester (equation *B*) was formed by direct transfer of the phosphate group.

In contrast with other investigations[3,6,11], the procedures employed in this study permitted measurement of the true initial rates of both the hydrolytic and transferase reactions. The initial velocities were determined using various donors (containing both high- and low-energy phosphate bonds), such as creatine, phenyl and glyceryl phosphates, and a number of different acceptors, such as glucose, fructose and glycerol. The results of these kinetic studies, which are summarized below, show the influence of a number of important factors on the transferase reaction.

*Acceptor concentration.* The data obtained using glucose as acceptor, and with creatine phosphate as donor, are typical and are illustrated in the accompanying graph. It is seen that, up to 2 *M* glucose, the initial rate of hydrolysis, that is, the liberation of inorganic phosphate, declines with increasing concentration of glucose, while simultaneously the initial rate of transfer, namely, glucose phosphate formed, increases. Hence there is little change in the rate of creatine liberation. Between 2 and 4 *M* glucose both the rates of hydrolysis and of transfer decline, apparently through non-specific effects of the high glucose concentration. However, the percentage transfer, that is, the ratio (μmoles glucose phosphate formed × 100)/μmoles creatine liberated (compare ref. 3), increases with increasing glucose concentration to a maximum value at about 2 *M* glucose and is unchanged by further increase of glucose concentration.

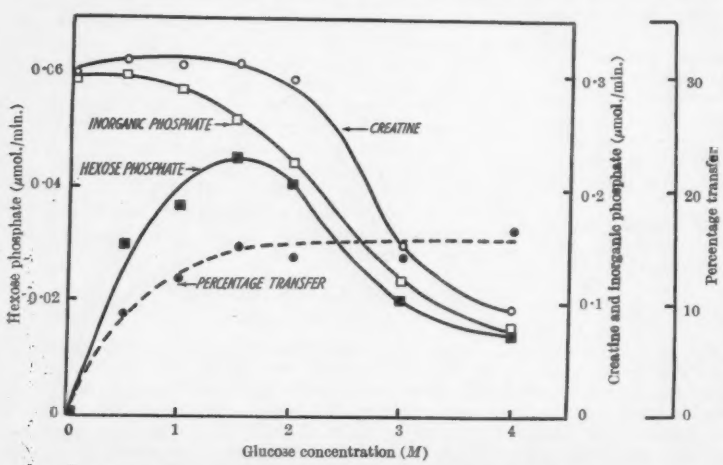
Essentially similar results were obtained with both fructose and glycerol, although the maximum percentage transfer differed from that obtained with glucose. However, no phosphorylation could be demonstrated when sucrose was used as an acceptor. Although sucrose was not phosphorylated, there was a continual decline in the rate of hydrolysis with increasing sucrose concentration, as noted with glucose.

*Donor concentration.* Both the initial rates of hydrolysis and of transfer were similarly influenced by changes in the donor concentration, and thus the percentage transfer remained independent. Similar findings have been reported for acid phosphatase[3]. The contrary findings by other workers[11] were no doubt due to the fact that true initial reaction-rates were not measured.

*Hydrogen-ion concentration.* Over the range *p*H 8·0 to 10·2 the percentage transfer was found to be independent of *p*H. The dependence of percentage transfer on *p*H found for plant acid phosphatases[3] was later attributed to the influence of *p*H on the bond energy of the donor[12]. However, as shown below, the donor bond energy does not determine the percentage transfer.

*Nature of the donor.* It has been claimed that the bond energy of the donor determines both the rate and efficiency of the transferase reaction catalysed by alkaline phosphatase[6], although the importance of the enzyme specificity in relation to the rate of reaction has been recognized[12]. However, the results given in the accompanying table show that the percentage transfer obtained with alkaline phosphatase is independent of the donor bond-energy. Thus, provided that true initial rates are measured, not only does β-glycerol phosphate give the same percentage transfer to glucose as does creatine phosphate but, indeed, the rate of the reaction with glycerol phosphate is very much greater than with creatine phosphate. The latter is a relatively poor substrate for alkaline phosphatase. It should be noted that the transfer from β-glycerol phosphate to glucose forms an ester of higher bond-energy than the donor.

Only those substrates which are hydrolysed by the enzyme, namely, true orthophosphomonoesters, phosphoamides, and related compounds such as




Influence of acceptor concentration on the transferase reaction of alkaline phosphatase. The reaction mixture contained glucose at the concentrations indicated, creatine phosphate (0·026 *M*), magnesium acetate (0·01 *M*) and purified intestinal alkaline phosphatase (9 μgm./0·5 ml.) in veronal buffer (*p*H 9·6). Incubation was at 37° C. for 5 min.

RELATIONSHIP BETWEEN PHOSPHATE BOND ENERGY OF THE DONOR AND THE PERCENTAGE TRANSFER WITH ALKALINE PHOSPHATASE

| Donor phosphate | Apparent $-\Delta F^{\circ}$* at *p*H 9·0 (calories) | Per cent transfer, estimated from initial velocity of reaction using 2 *M* glucose as acceptor |
|---|---|---|
| Creatine phosphate | 14,000 | 14 |
| Phenolphthalein phosphate | † | 14 |
| Phenyl phosphate | 4,200† | 18 |
| Glucose-6-phosphate | 3,000 | — |
| β-Glycerol phosphate | 2,200 | 16 |

* See refs. 18 and 24.
† Value estimated from published data for *p*-nitrophenyl phosphate[18].

phospho-enolpyruvate, act as donors for the transferase reaction. Since pyrophosphates are not attacked by the purified enzyme, neither hydrolysis nor transfer occurs when either adenosine tri- or di-phosphates are used as donors. However, adenosine-5-phosphate is a suitable donor, and shows similar percentage transfers to those found with other ortho-monophosphates.

There is evidence that the product of the transferase reaction with β-glycerol phosphate as donor and glycerol as acceptor is α-glycerol phosphate. Thus alkaline phosphatase catalyses a 'phosphomutase' reaction.

## Results with other Phosphatases

At *p*H 5·5 partially purified acid phosphatase from human prostate gland gave essentially similar results to those obtained with alkaline phosphatase at *p*H 9·6. Using the acid phosphatase, β-glycerol phosphate gave the same percentage transfer to glucose as did creatine phosphate, and the product in each case was glucose-6-phosphate (compare ref. 3).

No transferase reaction could be detected when the phosphatases of narrow substrate-specificity, namely, kidney hexose diphosphatase, 5-nucleotidase from bull testes, and muscle myosin-adenosine triphosphatase were used with their appropriate substrates and either glucose or glycerol as acceptors. Other workers[13] have reported that they were unable to demonstrate any transferase activity associated with the substrate-specific inorganic pyrophosphatase of yeast.

There was little or no decline in the rate of hydrolysis by such substrate-specific enzymes in the presence of quite high concentrations of potential phosphate-acceptors, such as glucose, glycerol and sucrose. In this respect these enzymes differed markedly from the enzymes of wide substrate-specificity (acid and alkaline phosphatases).

## Mechanism of the Transferase Reaction

The above results show that certain compounds containing hydroxyl groups can successfully compete with water for a site at the enzyme surfaces of the alkaline and acid phosphatases, but not at those of the substrate-specific phosphatases. The group-specific acid and alkaline phosphatases clearly have a measurable affinity for acceptors, such as glucose and glycerol, as well as water, and it is suggested that the enzymes which show strict specificity toward the donor also show strict specificity toward water as the phosphate acceptor.

Kinetic studies suggest that the reactions of the acid and alkaline phosphatases may be described by the following equations:

$$E + RP \rightleftharpoons E.RP \quad (1)$$

$$E.RP \rightleftharpoons EP\ (+\ R\text{O.H}) \quad (2)$$

$$EP + \text{H.OH} \rightleftharpoons EP.W \quad (3)$$

$$EP.W \rightarrow E + \text{H}P \quad (4)$$

$$EP + R'.\text{OH} \rightleftharpoons EP.A \quad (5)$$

$$EP.A \rightarrow E + R'P \quad (6)$$

where *E* is enzyme; *RP* is substrate (phosphate donor); *E.RP* is enzyme-substrate complex; *EP* is phosphorylated enzyme; *R*O.H is liberated alcohol; H.OH is water; *EP.W* is phosphorylated enzyme–water complex; H*P* is inorganic phosphate; *R'*.OH is acceptor; *EP.A* is phosphorylated enzyme-acceptor complex; *R'P* is acceptor phosphate (newly-formed ester).

The first reaction is probably the formation of an enzyme-substrate complex *E.RP* (equation 1), which gives rise to a further complex *EP* (equation 2). Since acid and alkaline phosphatases catalyse syntheses from inorganic phosphate, the latter must be regarded as a substrate of the enzyme, and *H* may be substituted for *R* in equations 1 and 2 above. The same complex, *EP*, is probably formed in both cases.

Some consideration has been given to the nature of the complex *EP*. Data obtained during these studies suggest that the enzyme may be phosphorylated following combination with the substrate. The complex *EP* therefore may represent the 'active enzyme' which contains a reactive phosphate group (possibly formed by phosphorylation of the phenolic hydroxyl of a tyrosine residue). This would be consistent with the important findings of other workers[14,15] that acid and alkaline phosphatases cause cleavage of the —O—P— bond of the substrate.

It is suggested that when acceptors, such as water or glucose, are activated at the enzyme surface by forming the complexes shown in equations 3 and 5, the reactive phosphate group passes to the acceptor, thus forming either inorganic phosphate or a new ester (equations 4 and 6).

Catalysis by the substrate-specific phosphatases may be described by equations 1, 2, 3 and 4. Since these enzymes have a relatively poor affinity for acceptors other than water, the addition of compounds such as glucose or glycerol, even in very high concentration, has little effect on the rate of hydrolysis. In the case of hexose diphosphatase, the combination between the enzyme and substrate probably involves an —SH group[16], and *EP* may well represent the 'active enzyme' which contains the thioester group —S—$PO_3H_2$. It has been shown that —SH groups are not involved in the combination of alkaline phosphatase with its substrates[17]. The need for the formation of a thioester bond, rather than a phenolic phosphate, is probably related to the differences in substrate specificity shown by hexose diphosphatase and alkaline phosphatase. In this connexion, it is noteworthy that the phosphokinases, which are all highly specific toward both donor and acceptor, appear to require integrity of —SH groups for combination between the enzyme and substrate[17,18].

A number of transfer reactions have been reported to be catalysed by various hydrolytic enzymes other than phosphatases. It seems likely that essentially similar mechanisms to those described above may be involved in the transfer reactions reported for enzymes such as β-glycosidases[1], fructo- and gluco-invertases[19,20], some proteinases[2,21,22] and certain peptidases[23]. All the hydrolytic enzymes for which transferase activity has been described exhibit a rather wide specificity toward substrates. It seems

very likely that, in general, the hydrolases of very narrow substrate specificity will be found to be devoid of associated transferase activity. In view of the evidence obtained with purified alkaline phosphatase, there seems no good reason for attributing any longer the transferase activity to enzymes associated with, but distinct from, the hydrolases.

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## BASIC MAGMA CHILLED AGAINST ACID MAGMA

WE, Wager in St. Kilda and a little later Bailey at Slieve Gullion, have recently been led, quite independently, to a novel conclusion concerning local inter-relations of certain basic and acid igneous rocks belonging to the British Tertiary province. Evidence from opposite ends of the province, 250 miles apart, forced us to postulate chilling and crystallization of basic magma against acid magma. We were at first reluctant to do this, but on second thoughts both of us, again independently, realized that since the temperature-range of crystallization for basic magma is a hundred or so degrees higher than that for acid magma, it is not unreasonable to postulate chilling of basic magma against cooler, but still liquid, acid magma.

The St. Kilda evidence comes from the complicated belt of rocks mapped by Cockburn[1] which lies between the earlier eucrite and the later Conachair granophyre. The chief rock in this zone is a fine-grained gabbro or dolerite, which has been extensively injected by microgranite, often with much interaction between the two (ref. 1, pp. 516–20, 530–33, 538–39). In addition, Cockburn has distinguished a fine-grained olivine–basalt intimately associated with the microgranite; it is the special relationships of the latter which in St. Kilda led to the new concept.

In the field, acid material often veins the basalt, showing that the acid magma was mobile after the basalt had solidified, but occasional critical pieces of field evidence indicate additional complications. Thus along the western shores of Village Bay and in the Dun Passage, the olivine–basalt material often occurs in the microgranite as series of alined blocks, among which individual blocks are either rounded or have one side cuspate to fit the rounded form of a neighbour. Some of the rows of blocks are believed to have resulted from basic magma injected into the acid magma, like pillow lava into water, but this arrangement apparently grades into others which are interpreted as the result of the pulling apart of the partly solidified basic magma during flow of the enclosing more acid material. The tearing apart sometimes occurred when the basic material was still essentially fluid, giving a string of blocks, more or less rounded; at other times it affected material that was essentially solid, when more angular blocks have resulted.

Textural relations vary correspondingly. In some cases the selvedge of the basic rock becomes increasingly fine-grained towards the margin for half a centimetre or so, as is clearly apparent both in the field and under the microscope (Fig. 1). The selvedge then reproduces the familiar effects of chilling of basic magma as seen elsewhere in small dykes and sills intruded into normal country rock. It is therefore in the present instance attributed to chilling of the basaltic magma against the adjacent acid. Where, however, the basic magma had solidified and then been fractured and penetrated by the still liquid acid magma, it does not show a fine-grained selvedge. Moreover, the acid material, often heterogeneous due to contamination with the earlier dolerite, does not in any circumstances show signs of chilling at its

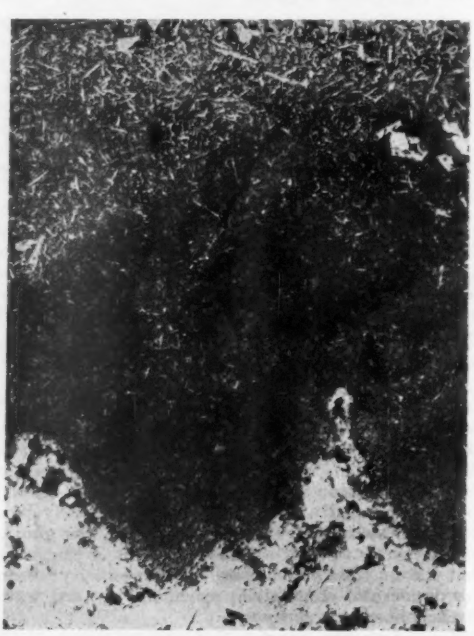

Fig. 1. Chilled contact of basalt against microgranite, 50 yards south of point where rocks first appear in position, south side of Village Bay, St. Kilda (× 7)

contact with the basalt; and its additional contamination in this position is only on a microscopic scale. The interest of these various phenomena was fully realized in the field, so that contacts were repeatedly examined. Eventually two cases of dyke-like masses of basic magma were found cutting acid rock and hybrid. There was definite chilling of the margin of the basic dyke, and yet acid magma was afterwards injected along occasional tears in it. Instances of this sort are likely to be rare, because there was much movement capable of tearing the basalt injections into detached blocks.

The chilled appearance of the contacts here described might be thought of as perhaps originating through metamorphism or metasomatism; also other explanations might be offered for the strings of rounded or cuspate inclusions of the basaltic rock in the acid. Several tentative hypotheses were tried in the field, but the one accounting most satisfactorily for the diverse and complex contacts between the basaltic rock and the microgranite starts with injection of basic magma into still hot and mobile acid material, with some rapid crystallization of basalt at the contact due to a certain degree of chilling. Subsequent movement has often involved the tearing apart of the basalt at different stages in its solidification, and this has given another type of basalt–granite contact without evidence of chilling.

At Slieve Gullion the idea of basic magma chilling against acid arose out of consideration of certain relationships recently described by Doris Reynolds[2]. She has in places identified what she takes to be chilled pillowy surfaces of basic lava, which latter, she thinks, has been metamorphosed, a few inches away, into hypersthene–dolerite. Against the chilled surfaces she found that granophyre has not infrequently crystallized; and within the chilled zones she recognized indications of contact-alteration, including micro-granulitization of augite rods (ref. 2, pp. 91, 96–98, 119, 133, 140). A visit to three cited localities showed that appearances do not correspond closely with those presented by pillow lavas in other parts of the world. The differences are, in fact, so great as to render it very difficult to imagine that the observed chilling can be ascribed to contact with water, the agent responsible for surface chilling in the case of pillow lavas. In most respects, however, the descriptions given have been confirmed. Thus Fig. 2 is a microphotograph of a specimen collected at the most representative 'pillow' locality, and illustrates a contact of chilled basalt against granophyre, the former merging outside the field of view into dolerite. Two things are abundantly clear: (1) progressive reduction of basaltic texture towards the contact; and (2) crystallization of the granophyre against the contact, as indicated by arrangement of marginal growths of hornblende and magnetite. In addition, though the photograph fails to reproduce it, the slide itself reveals under the microscope positive evidence of contact-alteration of the chilled basalt.

As a straightforward interpretation it is claimed that basic magma has risen into contact with acid magma, and has cooled sufficiently against it to develop within itself a marginal, interliquid crust. This, on its basic side, has continuously grown with at first increasing coarseness of grain; while on its other side, it has, after some delay, furnished attachment for crystallization from the acid magma, slightly contaminated. In such circumstances, it is understandable that the chilled basaltic crust, held

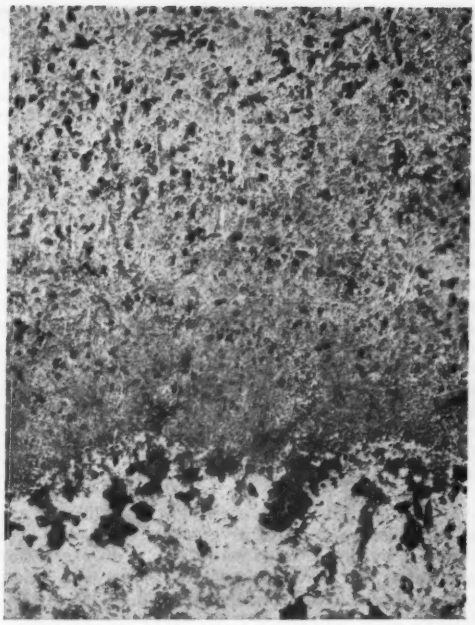

Fig. 2. Contact of chilled subvariolitic basaltic edge of dolerite against granophyre, N.E. side of lane 1 mile 800 yards south (a little west) of Slieve Gullion summit (× 10)

for a long time above the crystallization temperature of adjacent acid magma, should show a certain amount of contact-alteration (annealing).

This interpretation is greatly strengthened in that it can be applied without modification to analogous neighbouring exposures where everyone agrees that geometry forbids a pillow-lava hypothesis. Thus we read of "hypersthene-dolerite cut by veins of granophyre", and "yet the hypersthene-dolerite has fine-grained edges resembling chilled edges" (ref. 2, pl. I, 3); and again, in relation to a microphotograph of the result (ref. 2, pl. II, 5)—very like our own Fig. 2 but from a different locality: "The field shows phenocrysts of pyroxene and crystallites of plagioclase in a subvariolitic matrix. The texture of the matrix becomes even finer-grained as the granophyre is approached. A few inches from the contact the hypersthene-dolerite has a grain-size of from ·2 to 1·1 mm."—in contrast to almost nothing near the granophyre. This towards-margin diminution of grain-size is taken by Bailey once again to denote chilling. It is difficult to see how it can be due to remelting, as advocated by Reynolds (ref. 2, pp. 118–122), or yet to metamorphism, Richey's alternative[3].

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Prof. L. R. Wager and Sir Edward Bailey write: "Evidence from opposite ends of the [British Tertiary] province, 250 miles apart, forced us to postulate

chilling and crystallization of basic magma against acid magma". Since, so far as the southern end of the province is concerned, their "evidence" is a re-interpretation of observations made by me at Slieve Gullion, I feel it necessary to point out the incompatibility of the re-interpretation with my published observations[1,2].

At Slieve Gullion a pile of gently dipping layers of dolerites of various compositions and textures is transgressed by plug-like masses, veins and net-veins of granophyre or related types of acid rock. The point of immediate importance is that study of the relationships of the dolerite layers to one another and to the transgressive granophyres revealed the presence of fine-grained edges which cannot all have originated in the same way. Two of the basic layers resemble sills in that they exhibit fine-grained margins at both their upper and lower contacts. The fine-grained edges of sills adjoin pre-existing rocks which were relatively cold when the sills were intruded, and it is for this reason that such fine-grained edges are commonly interpreted as chilled edges.

In the lower part of the pile the dolerite at some localities exhibits pillow structure, the pillow forms, which measure 2–8 ft. in greatest diameter, being bounded by fine-grained selvedges. Pillow structure is a relatively rare geological phenomenon, known only in basic lavas. Knowledge as to its origin is derived from present-day observations that pillow structures form when certain basaltic lavas flow into water, rapid surface chilling accounting for the fine-grained edges of the pillows. Bailey's interpretation of the Slieve Gullion pillow structures as a consequence of basic magma rising into contact with acid magma has no observational background, and is, moreover, inconsistent with the evidence provided by the rocks themselves. His interpretation implies that the fine-grained edges of the pillow structures always adjoin acid rock. This is not the case. Although veins of acid material have commonly been emplaced along the boundaries of the pillows, there are abundant examples of contiguous pillow structures without intervening acid rock. In these examples the fine-grained edges are still present and in juxtaposition with one another. Consistent with my own interpretation of the pillow structures as having originated in the normal way as a consequence of basaltic lava flowing into water is the occasional discovery[1], by crofters, of small pockets of 'coal' within rocks exhibiting pillow structure. The 'coal', which burns well, is possibly carbonized wood derived from trees which, like Macculloch's Tree in Mull, were engulfed in the lava-flows.

As already noted, the dolerite layers are transgressed by plug-like masses, veins and net-veins of granophyre against which the dolerites commonly exhibit fine-grained edges. Since these fine-grained edges in many respects resemble the fine-grained edges of the sills and pillow structures, Bailey supposes them to be edges of masses of basic magma which were chilled against relatively cool acid magma. It is mechanically impossible for acid net-veins to be a result of basic magma rising into acid. Apart from this, it is evident in the field that the plug-like masses and veins of granophyre commonly transgress the lineations of the dolerites. These granophyres and the adjacent fine-grained edges of the dolerite therefore post-date the crystallization of the dolerites. There is, moreover, evidence that these fine-grained margins represent dolerite which had melted at the time of the emplacement of the magma (or other mobile antecedent) of the granophyre. Where granophyre veins transgress dolerite characterized by phenocrysts of bytownite, the fine-grained dolerite edges contain corroded relics of bytownite which are dissected by stringers of pale yellowish glass such as result from partial melting. The refractive index of the glass (1·5331) is consistent with its having a composition $An_{53}$ corresponding to that of the liquid which would form first if the bytownite were fused[2]. By reference to the thermal equilibrium diagram of the plagioclases[3], the temperature at which liquid of composition $An_{53}$ would form from the bytownite concerned is 1,458° C. at atmospheric pressure. Evidence[1] indicates, however, that the melting took place at a water-vapour pressure of the order of 300 bars. The lowering of the fusion temperature of albite in the albite – water system at a vapour pressure of 300 bars is about 103° C.[4]. If the lowering of the fusion temperature of the bytownite concerned, in the presence of water vapour, is of the same order, then the partial fusion of the bytownite may be taken as indicating a minimum temperature of about 1,355° C. At this temperature a high proportion of what is now the fine-grained margin of the dolerite would be melted. From the presence of swallow-tail plagioclases in many of the fine-grained edges, it can be inferred that the melted material mainly solidified as glass which has since devitrified.

These criteria are important not only in demonstrating the origin of the fine-grained edges of the dolerites adjoining transgressive granophyre, but also in providing, so far as I know, the first recorded geological evidence as to the temperature of a granophyre 'magma'. Wager and Bailey make no reference to the paper[2] in which the details of my investigation are recorded, although at a symposium on the origin of gabbro held by the Royal Society of Edinburgh on February 16 of this year, in which they took part, I cited this evidence, with reference to the Campbell volume[2] in which it is published and to which Bailey himself contributed.

So far as the rocks of the Slieve Gullion area are concerned, Wager and Bailey's hypothesis is demonstrably not valid. Apart from the presence of fine-grained edges, the evidence alluded to by Wager from St. Kilda relates to field structures of associated basic and acid rocks, which he states "are believed to have resulted from . . ." and, later, "are interpreted as . . .". This is far from being evidence at all. By using ordinary structural methods, such as were applied to crystalline rocks more than a quarter of a century ago by H. Cloos, it should be possible to demonstrate whether or not the structures observed by Wager are consistent with his interpretations. Wager, however, makes no reference to applied techniques, and provides no criteria by which the adequacy of his hypothesis can be judged. A fine-grained edge is a fact, but the ascription of it to chilling is a hypothesis, and it is by no means a foregone conclusion that every fine-grained edge is a chilled edge.

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# LETTERS TO THE EDITORS

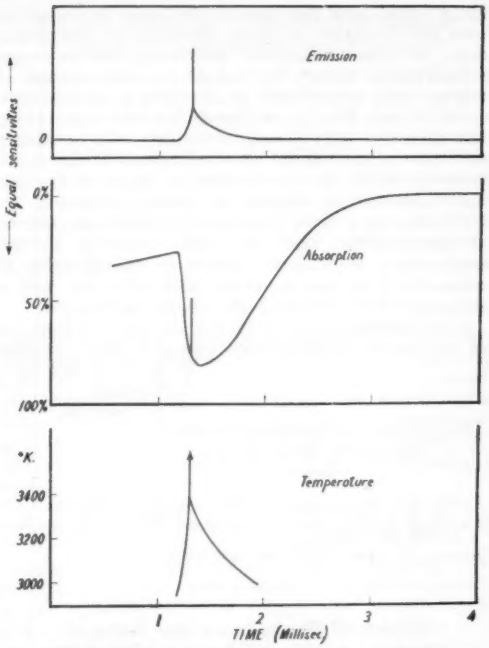
*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Chemiluminescent Phenomena during Hydrocarbon Combustion

THE light emission accompanying the combustion of hydrocarbons in explosions and high-temperature flames has received a great deal of attention and it seems generally agreed that, while normal thermal radiation is present, part of the radiation is non-thermal in origin. Most of the studies have been concerned with radiation which is an integration of light emission over a period of time during which many different stages of reaction and excitation may occur. By means of flash photolysis, we have described how homogeneous initiation of explosions may be brought about and relative radical concentrations measured as a function of time throughout the reaction[1,2]. In order to investigate reversal temperatures and the problem of chemiluminescence, we have now extended our work to the kinetic recording of emission and absorption spectra by photo-electric methods. For this purpose, the spectrograph plate-holder was replaced by a mounting carrying photomultiplier cells behind adjustable slits. The photocell outputs were fed through D.C. amplifiers on to an oscillograph, the overall response-time being about $10^{-6}$ sec. For absorption measurements the light from a xenon arc was focused first in the centre of the reaction vessel and then on to the spectrograph slit by means of quartz lenses. In these ways it was possible to record very rapid changes in the emission or absorption of selected spectral regions. This has revealed several remarkable features which were not apparent in the earlier work and which have an important bearing on the problem of radiation from combustion processes.

The light emission from homogeneously initiated explosions of acetylene and oxygen containing a small amount of nitrogen dioxide as photosensitizer have been recorded as a function of time in a number of wave-length regions each covering about 40 A. The emission curves in regions where radical spectra are not present, that is, from the continuous spectrum, were similar in shape and duration to the absorption curves of carbon radicals in acetylene-rich mixtures[2]. The emission at wave-lengths corresponding to the spectra of free radicals such as $C_2$, CH and CN were many times more intense and in addition showed superposed peaks of very short duration. A typical oscillograph record of the latter type, for a fuel-rich system, is shown in the accompanying graphs. It was taken in the region which contains the head of the 0,0 sequence of CN. Near the maximum of the main curve is a superposed peak lasting only a few microseconds, the maximum intensity of which is considerably greater than that of the main emission. Very many examples of this phenomenon have been observed, and although a single peak was generally found in the position shown here, in some cases several peaks were observed during the rise.

The superposed peak seems to be quite separate from the main curve, and the question arises as to whether this implies a sudden rise and decay in the concentration of the radical or a similar rise and decay in the apparent temperature. The problem should be definitely settled by recording the absorption spectrum of the same explosion. This was done in




Emission, absorption and temperature of CN as a function of time during an explosion of acetylene, oxygen and nitrogen dioxide at pressures of 14, 10 and 1·5 mm. mercury, respectively

our previous work, but the flash spectroscopic technique had not the time-resolution necessary for such a peak to be detected. The absorption curve now obtained using the same methods of detection as for the emission experiment is plotted below the emission curve in the accompanying figure. It shows quite clearly that the second peak appears in the opposite sense to the main absorption and is therefore a result of an increase in apparent temperature, since an increase in concentration of the radical alone would, of course, result in increased absorption. The peak heights, averaged from a number of records, were the same in emission and absorption, so that, although the effective temperature of the source lamp was 4,070° K., there was no reversal of the peak.

The brightness temperature of the xenon arc at each wave-length was determined by photographic comparison with a calibrated tungsten filament lamp, corrections being applied for light losses at the various interfaces. By combining these temperatures with the curves of emission and absorption, it is possible to obtain measurements of the temperature of the explosion throughout the part showing appreciable emission[3]. These measurements are given in the third trace in the figure, the absolute error over the main curve being estimated as $\pm 100°$ K. The 'temperature' of the CN radical at the maximum of the superposed peak is probably very much higher than suggested by these experiments, since its emission is only significant over a fraction of the wave-length range used whereas the light-source gives a continuous spectrum over the whole region.

The emission over the main part of the curve probably results from normal thermal excitation. The temperatures, although in excess of the theoretical maximum temperature, are reasonable when the additional heat supplied by the initial flash is taken

into account, and this part of the curve is similar in form and duration to those obtained in absorption under the same conditions, indicating that its shape is determined mainly by change in concentration of radical. The superposed peak shows a temperature rise of at least 400° K., and probably very much more than this, in one or two microseconds. These results establish beyond doubt the occurrence of radiation processes which are non-thermal in origin, and which must therefore be classed as chemiluminescent. In particular, they show that such processes appear to be disconnected from the main reaction, do not result in any appreciable permanent change either in temperature or concentration, and occur for only a relatively short period of the whole combustion.

A full account of this work will shortly be submitted for publication in the *Proceedings of the Royal Society*.

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## Effect of Phenols on the Rate of Decomposition of Benzoyl Peroxide

The decomposition of benzoyl peroxide in solution occurs by unimolecular fission into two radicals :

$$P \rightarrow 2R\text{—}. \qquad (1)$$

In 'reactive' solvents (*S*H) this is accompanied by an induced chain-decomposition[1], namely,

$$R\text{—} + S\text{H} \rightarrow R\text{H} + S\text{—}. \qquad (2)$$

$$S\text{—} + P \rightarrow \text{Products} + R\text{—}. \qquad (3)$$

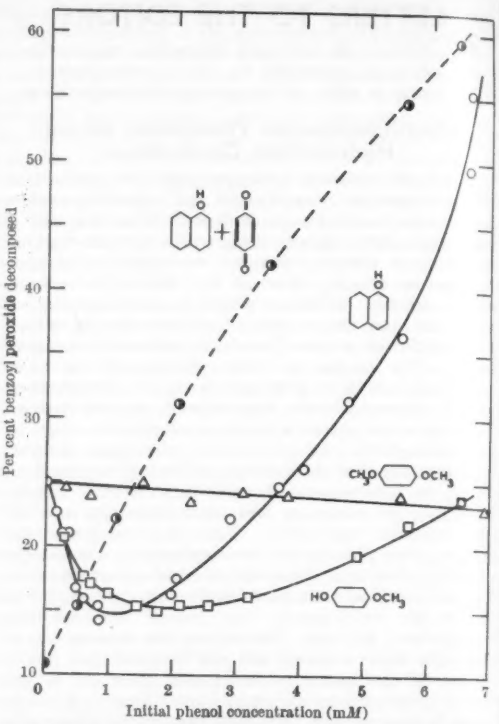
Previous workers have found the induced reaction to be inhibited by quinol[1] and *m*-cresol[2]. On the other hand, when a phenol is used as solvent, it is greatly accelerated[3].

We have examined the effect of increasing concentration of several phenols on the rate of decomposition in various solvents in the absence of oxygen. Results for 1-naphthol and *p*-methoxy phenol (and *p*-dimethoxy benzene) are given in the accompanying graph, in which the percentage peroxide decomposed in 45 min. at 80·65° C. in *cyclo*hexane is plotted against the initial concentration of the phenol. The effect thus depends on the concentration of phenol. Small amounts of phenol inhibit the reaction, but with increasing concentration the rate passes through a minimum and thereafter increases. Similar results were obtained with 2-naphthol and quinol ; though with quinol, observation of the minimum was prevented by its low solubility in *cyclo*hexane. The minimum was observed, however, when the decomposition was carried out in dioxane.

Inhibition of free-radical reactions by phenols (*F*H) is generally ascribed to low reactivity of the radical *F*—. In the present case, however, the accelerating effect of high phenol concentrations indicates that the reaction :

$$F\text{—} + P \rightarrow \text{Products} + R\text{—} \qquad (4)$$

is relatively fast. It is evidently considerably faster than reaction (3). We suggest tentatively that the




Fraction (in per cent) of benzoyl peroxide decomposed in 45 min. at 80·65° C. as a function of initial phenol concentration. Initial peroxide concentration in all experiments, 0·017 mol. litre$^{-1}$. Full curves : 1-naphthol, *p*-methoxy phenol and *p*-dimethoxy benzene in *cyclo*hexane. Dotted curve : 1-naphthol in *cyclo*hexane containing 0·0030 mol. litre$^{-1}$ *p*-benzoquinone. (Results are not corrected for a small residual concentration of *p*-benzoquinone, which interferes with the iodometric peroxide determination ; the corrected curve would be a little steeper than that shown)

inhibition of benzoyl peroxide decomposition by phenols is due to the reaction

$$F\text{—} + S\text{—} \rightarrow \text{Inactive products}, \qquad (5)$$

*F*— being derived from

$$R\text{—} + F\text{H} \rightarrow R\text{H} + F\text{—}. \qquad (6)[3,4]$$

The increase in rate from the minimum thus occurs when sufficient phenol is present to reduce the concentration of *S*— to a low level. At high phenol concentrations the decomposition then proceeds in the main by the sequence (1) (6) (4). Chain termination probably occurs principally by the reaction

$$F\text{—} + R\text{—} \rightarrow \text{Inactive products}, \qquad (7)$$

(7) being slower than (5). (Reaction 7 is required to explain the first-order kinetics of the decomposition in phenol solution[2] ; cf. ref. 2.) This explanation is supported by the fact that when the concentration of *S*— is reduced effectively to zero by adding a sufficient concentration of an inhibitor of a different type (*p*-benzoquinone), the rate progressively rises with increasing phenol concentration (cf. dotted curve in graph). Similar behaviour is shown by quinol and 1-naphthol in the presence of *p*-benzoquinone in dioxane.

The results thus also show that the effect of quinol on the decomposition is not qualitatively different

from that of monohydric phenols. Replacement of both hydroxy groups by methoxy groups, however, markedly reduces the reactivity (see graph).

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## Reaction of Nitric Oxide with Gaseous Hydrocarbon Free Radicals

The inhibiting effect of nitric oxide upon radical chain-reactions in the decomposition of certain organic compounds is well known[1], and such mechanisms as

$$CH_3 + NO \rightarrow CH_3NO \rightarrow H_2CNOH \rightarrow HCN + H_2O$$

have been invoked to explain this inhibition. Although Küchler and Theile[2] obtained traces of cyanide from the nitric oxide-inhibited decomposition of ethane, in no case has the nitroso compound been isolated in such reactions. Coe and Doumani[3] prepared nitrosomethane from the photolysis of *tert.*-butyl nitrite.

As part of a systematic study of decomposition-rates of metal alkyls, we have pyrolysed mercury di-*iso*propyl in a flow system using a carrier gas of nitrogen and nitric oxide. The nitric oxide is rapidly consumed by reaction with *iso*propyl radicals. We have trapped out a yellow solid (presumably 2-nitrosopropane) which melts at about − 85° C. to form a yellow-brown liquid. This liquid speedily changes to a white solid at this temperature. The solid contains both nitroso and oxime groups[4] and exhibits absorption spectra characteristic of acetoxime and a nitroso compound[5]. The ethereal solution is blue, the colour rapidly fading. A series of papers on the reaction of nitric oxide with this and other free alkyl and aryl radicals will be submitted elsewhere for publication.

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## Proton Acceptor Properties of Deeply Coloured *Cyclo*pentadiene Polymers

*Cyclo*pentadiene can be converted catalytically, by trichloroacetic acid, into a brown-red poly*cyclo*pentadiene – trichloroacetic acid ester, (I), the colour of which is due to conjugated double bonds[1]. If this ester is brought into contact with sufficiently concentrated strong acids, a dark blue, almost black, molecular compound, (II), is immediately formed. In tests in which the concentrations are small, or in which weaker acids are used, the colour of this compound is greenish-blue or green.

The reversible reaction :

$$(I) + (HA) \rightleftharpoons (II) \qquad (1)$$

has now been investigated quantitatively, (H*A*) being the three chloroacetic acids. Hydrochloric, sulphuric and β-naphthalene sulphonic acids were also tested, but were found to be unsuitable for quantitative measurements because the solubilities in appropriate solvents were too low. The equilibrium constant, *K*, of reaction (1) can be represented by the surprisingly simple relationship :

$$K = \frac{[\Sigma x_r]}{[\Sigma(P_r - x_r)]\,[HA]} = \frac{D_{I+II} - D_I}{(D_{II} - D_{I+II})\,[HA]}, \qquad (2)$$

where $[\Sigma x_r]$ and $[\Sigma(P_r - x_r)]$ are the equilibrium concentration of (II) and (I), [H*A*] is the concentration of the chloroacetic acid (which was always much greater than [I] ), $D_{I+II}$ is the optical density of a mixture of (I) and (II), $D_{II}$ is the optical density at an acid concentration sufficiently high to convert all the polymer into (II), and $D_I$ is the optical density in the absence of acid. The validity of equation (2) has been established by many experiments in the concentration-range shown in columns 2 and 3 of the accompanying table, light of 700 mμ being used for the determination of the optical densities. It has also been established at 15°, 20° and 37° and with nitrobenzene as solvent.

Results of Equilibrium and Electrical Conductivity Measurements : Benzene Solution, 25·0°

| | Conc. range of equilibrium tests | | *K* (l./gm.-mol.) | Conc. range of II in conductivity tests* ($10^4$ number average gm.-mol./l.) | Λ × $10^4$ (ohm$^{-1}$ × cm.$^2$/number average gm.-mol.) |
|---|---|---|---|---|---|
| | Acid (gm.-mol./l.) | Polymer ($10^4$ number average gm.-mol./l.) | | | |
| $Cl_3CCOOH$ | 0·0435–2·44 | 0·690–8·28 | 8·1 ± 1 | 29·2–59·2 | 7·9– 39 |
| $Cl_2HCCOOH$ | 0·155 –6·05 | 0·828–8·28 | 0·82 ± 0·13 | 12·9–30·9 | 24 – 75 |
| $ClH_2CCOOH$ | 0·325 –1·56 | 5·40 | 0·028 ± 0·006 | 1·07–2·62 | 160 – 500 |

* In these measurements (H*A*) was varied in the range 0·1–1·6 gm.-mol./l. Results of tests at other concentrations will be given elsewhere.

On plotting log *K* (*K* in fourth column of table) against the logarithm of the dissociation constants of the three chloroacetic acids in water, a linear relationship of the Brønsted type holds, which is compatible with the supposition that (I), owing to the π-electrons of the conjugated double bonds, is a proton acceptor[2], and that (II) is a salt. A proton transfer mechanism in the formation of these deeply coloured molecular compounds is consistent with the observation that relatively strong proton acceptors such as piperidine, dioxane, ethyl alcohol or acetone prevent the formation of (II) ; no such 'inhibition' occurs with polar aprotic solvents, for example, nitrobenzene or chloroform. This mechanism is proved by the marked electrical conductivity of dry benzene solutions containing (II), control experiments having established that the electrical conductivity of a benzene solution containing either (I) or (H*A*) alone is not significant. The 'molar' electrical conductivities, Λ, of (II), relating to the specified concentration-range, are

listed in the last column of the table; they are of the same order of magnitude as those of authentic salts in benzene solution[3].

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## Preparation of Aluminium Tri-Soaps

The aluminium salts of higher fatty acids find considerable use for various industrial purposes. Their nature and composition are, however, surprisingly obscure. Even the existence of the tri-soaps has been doubted by a number of workers[1], whereas Lawrence[2] believes that tri-soaps of aluminium do exist, and Glazer, McRoberts and Schuman[3] have reported the preparation of aluminium tri-laurate by the reaction between aluminium tri-methyl and lauric acid.

In this communication is described the preparation of the tri-palmitate and tri-stearate of aluminium by the following reaction in the presence of benzene, the *iso*propanol produced being removed azeotropically with the solvent:

$$Al(OPr^i)_3 + 3RCOOH = Al(RCOO)_3 + 3Pr^iOH.$$

1·51 gm. of freshly distilled aluminium *iso*propoxide (1 mole) and 6·30 gm. of double-distilled stearic acid (3 moles) in 80 c.c. of dry benzene were refluxed at a bath temperature of 140–150° C. under a column (60 cm. long filled with Fenske helices) fitted to a total-condensation variable take-off stillhead. 3·6 gm. of distillate was collected in one hour at 72–73° C. and on analysis was found to contain 1·05 gm. of *iso*propanol; 20 gm. of distillate collected between 77° and 80° C. was found to contain about 0·2 gm. of *iso*propanol. Refluxing was continued for another four hours and the distillate was collected at 80° C. under a high reflux ratio (1 : 20). The remaining benzene (about 10 c.c.) was removed by distillation under reduced pressure and the product (a white solid) was heated at 200–220° C. under 0·2 mm. pressure for one hour. The hard white solid thus obtained was analysed: found: Al, 3·09; C, 74·13; H, 12·02 per cent. Al(stearate)$_3$ requires Al, 3·07; C, 73·92; H, 12·07 per cent.

Aluminium tri-palmitate prepared by a similar procedure was a slightly yellow solid which on analysis gave Al, 3·42; C, 72·64; H, 11·90 per cent; Al(palmitate)$_3$ requires Al, 3·40; C, 72·68; H, 11·81 per cent.

The method of preparation appears to be a general one and has been extended to the soaps of titanium and zirconium. Further work on the physical characteristics of these soaps is planned to establish their constitution.

The carbon and hydrogen analyses were carried out by Messrs. Weiler and Strauss, Oxford.

These investigations were carried out at Birkbeck College, University of London. I am grateful to Prof. W. Wardlaw and Dr. D. C. Bradley for their interest and encouragement and to the British Council for a fellowship.

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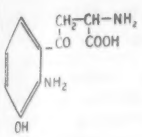
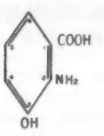
## A Possible Common Biogenetic Origin of the Nicotine, Tropane and Hygrine Bases

The isolation of both hyoscine and nicotine from a genotype of *Duboisia myoporoides*[1] suggests the possibility of a close biosynthetic relation between these bases, and is consequently of interest in connexion with the classical schemes of alkaloid biogenesis[2]. However, a synthesis of nicotine or a related compound under so-called physiological conditions has not yet been effected, and it seems desirable to consider a possible alternative mechanism.

Since the publication of a review by R. F. Dawson[3] on alkaloid biogenesis, the metabolic pathway to nicotinic acid from tryptophane has become better known, and evidence that the conversion proceeds by way of the intermediates kynurenine, 3-hydroxykynurenine (I), and 3-hydroxyanthranilic acid (II) is accumulating[4]. It would now seem feasible that the simple 3-substituted pyridine derivatives trigonelline, ricinine and the areca nut alkaloids may likewise be products of this mode of tryptophane metabolism, and result from 3-hydroxyanthranilic acid, which itself occurs in the form of the methyl ester of its O,N-dimethyl derivative as the alkaloid damascenine. In nicotine and related bases, the pyridine ring may have a similar origin, arising by cleavage of the benzene ring in (I) or (II), followed by recyclization. The pyrrolidine ring of *nor*-nicotine could be built up from all or part of the carbon chain already present in (I), or by condensation of (II) or a metabolite of (II) with, for example, acetic acid and glycine, followed by decarboxylation. Such an origin permits the formation of both D$_S$ and L$_S$ *nor*-nicotine; both isomers are found, *nor*-nicotine in *Nicotiana* spp.[5,6] being mainly of the L$_S$ form but the D$_S$ isomer predominating in *D. hopwoodii*[6–8]. The occurrence of both isomers would suggest that the pyrrolidine ring does not arise directly from L$_S$ proline[9]. Apparently nicotine occurs in the L$_S$ form only, even in *D. hopwoodii*[6,9,10]. This is possibly due to failure of biological methylation to take place with D$_S$ *nor*-nicotine.

This speculation receives added interest from the fact that cleavage of the benzenoid ring of (II) between C$_1$ and C$_2$ would lead to a C$_7$N intermediate such as (III), which, on appropriate cyclization, would give rise to the *nor*-tropanone skeleton (IV). The oxygen atoms in (III) are suitably placed to accommodate the naturally occurring oxygenated tropanes. In dihydroxytropane and valeroidins, the oxygen on C$_3$ is retained as a hydroxy group; in hyoscine it is present in an epoxide ring; in meteloidine the epoxide ring, probably of the diastereoisomer of hyoscine, is opened to form the *cis*-glycol. In addition, the side-chains in ecgonine and dioscorine are accounted for as being possibly derived from the side-chain of (I).


(I)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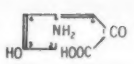
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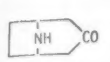
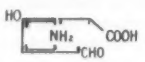

(IV)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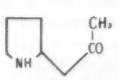
(VI)

An alternative carbon chain (V), from which the *nor*-tropanone structure could conceivably be derived, would be obtained by cleavage of the benzenoid ring of (II) between $C_6$ and $C_1$.

In *Erythroxylon truxillense*, tropane bases are accompanied by hygrine, and both types of alkaloids are found in the genus *Convolvulus*[11]. Also hyoscyamine and cuskhygrine are reported to occur together in *Scopolia lurida*. These co-occurrences likewise are probably of biogenetic significance, and the hypothetical intermediate (III), which serves above as a source of the tropane structure, could also give rise to the *nor*-hygrine structure (VI) by the appropriate cyclization. The longer carbon chain of cuskhygrine is difficult to account for by this hypothesis. It may be that the plant contains an enzyme system by which hygrine or a precursor is condensed with a compound such as 4-methylaminobutanal.

I wish to thank Dr. J. R. Price and Dr. C. C. J. Culvenor for advice and criticism.

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## Action of Ninhydrin on Keratin

Although ninhydrin has long been used as a sensitive reagent for the detection of amino-acids, its remarkable cross-linking action on protein fibres appears to be unknown. In the case of wool keratin, the reaction, the extent of which is independent of *p*H between *p*H 4·8 and 8·3, takes place slowly at ordinary temperatures and is incomplete in 48 hr. With a boiling 0·0685 *M* solution at *p*H 4·8, however, cross-linking proceeds so rapidly that after treatment for 15 min. the fibres show a 25·8 per cent increase in resistance to extension (30 per cent) in water at 22·2° C. Since the extent of reaction is reduced when the lysine side-chains are blocked by means of 1-fluoro-2 : 4-dinitrobenzene or nitrosobenzene, and since no strengthening is obtained with completely deaminated fibres, the basic side-chains of keratin must play a fundamental part in the cross-linking reaction.

Besides being capable of strengthening intact fibres, ninhydrin is even more effective with damaged fibres. When, for example, wool fibres were treated with thioglycollic acid until their resistance to extension in water at 22·2° C. was reduced 23·9 per cent, subsequent treatment with the boiling solution of ninhydrin for 15 min. gave fibres the resistance of which to extension was 21·9 per cent greater than that of untreated fibres.

Ninhydrin is thus by far the most effective cross-linking agent so far discovered for keratin, and there is every reason to expect that related compounds, which give uncoloured derivatives, will find extended use in processes for reinforcing protein synthetic fibres as well as natural fibres.

We are indebted to the International Wool Secretariat for grants in aid of this investigation.

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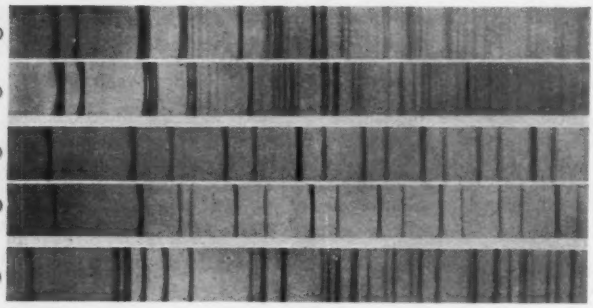
## Alkaline Earth Uranates of the $R_3MX_6$ Type

Alkaline earth uranates of the $RMX_4$ type are well known and the crystal structures of, for example, the calcium and strontium compounds $CaUO_4$ and $SrUO_4$, respectively, have been investigated in detail[1].

While studying phosphors of the CaO(U) type, it was decided to investigate the formation of other possible uranate compounds. A range of samples containing varying ratios of calcium to uranium was prepared and a transition in fluorescence properties was observed at a 3 : 1 ratio. It was suspected that a calcium compound having the composition 3CaO : $1UO_3$ had been prepared, and an X-ray investigation showed the existence of a new compound. Other similar uranates were prepared and it was found that the new materials possessed the same pseudo-cubic crystal structure as alkaline earth tungstates of the $R_2WO_6$ type[2], and fluorides of the cryolite, $Na_3AlF_6$, type[3].

The above tungstates and fluorides approach and attain full cubic symmetry (space group $Fm3m$) when ionic dimensions are favourable. The ideal structure involves cations occupying two different sites with relative abundance of 2 : 1. For this reason, and because ionic radii are favourable, $Ba_3CaWO_6$ possesses the full symmetry of the $Fm3m$ cubic space group. With this in mind, the further uranate $Ba_2CaUO_6$ was prepared. The X-ray powder photograph, while revealing slight deformation from the fully cubic arrangement, owing no doubt to the difference in volume between the $UO_6$ group and the $WO_6$ group, confirmed that the uranates follow the same general behaviour as the corresponding tungstates.

To check the isomorphism of the tungstate and uranate systems, the intermediate compound $Ca_3(0{\cdot}5W\ 0{\cdot}5U)O_6$ was prepared. The resulting material was found to be a complete solid solution and to possess a pseudo-cubic structure cell dimension of $a_0 = 8{\cdot}1_6$ A., compared with $8{\cdot}0_2$ A. for $Ca_3WO_6$ and $8{\cdot}2_9$ A. for $Ca_3UO_6$. X-ray powder photographs of $Ca_3UO_6$, $Ba_2CaUO_6$ and, for comparison purposes, $CaUO_4$, $Ca_3WO_6$ and $Ba_2CaWO_6$, are reproduced herewith.




X-ray powder photographs of: (*a*) $Ca_3UO_6$; (*b*) $Ca_3WO_6$; (*c*) $Ba_2CaUO_6$; (*d*) $Ba_2CaWO_4$; (*e*) $CaUO_4$.
19-cm. diameter camera; copper $K\alpha$ radiation

Synthesis of the various compounds was accomplished as follows. Using appropriate molecular proportions, alkaline earth carbonate was made into a paste with uranyl nitrate solution; where necessary, tungstic oxide was mixed with the carbonate. The resultant paste was dried at 250° C. and fired for one hour at a temperature in the range 1,150–1,350° C., according to which compound was being prepared. The $R_3MX_6$-type uranates are pale-yellow in appearance.

In common with other uranium compounds, the fluorescence spectra show many interesting features. For example, at liquid-air temperature the fluorescence of $Ca_3UO_6$ under long wave-length ultraviolet radiation is yellow-green and of medium intensity. The emission consists of a continuous band with a superimposed set of lines or sharp bands, whereas at room temperatures there is a weak diffuse green fluorescence.

Different spectra, but of the same general type, are obtained with the other uranates such as $Ba_2CaUO_6$. When activated with samarium or europium, these phosphors show, especially at low temperatures, a strong fluorescence exhibiting the characteristic line spectrum of the particular rare-earth activator. With samarium a predominantly orange fluorescence is obtained and with europium the fluorescence is orange-red.

It is hoped to publish a fuller account of the fluorescent properties of these uranates and of related phosphors at a later date.

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## Irradiation of Polymers by High-Energy Electrons

The interaction of high-energy radiation with various forms of matter has been shown to produce a variety of chemical effects, depending upon the system. These effects fall into various classes, among which are oxidation and reduction, polymerization and depolymerization. Recently, Charlesby and Little have reported the cross-linking of polymers by high-energy radiation[1–3].

Our work in this field has been with high-energy electrons, such as are produced by a resonant transformer-type cathode ray equipment, which supplied electrons having peak energy of 800 kV.[4]. We have covered a dose-range from below one million to several hundred million röntgen units. Most of the work which Charlesby[1,2] has reported to date has been with radiation from an atomic pile, although Little[3] has made a study of the crystallinity of polymers irradiated by electrons from a Van de Graaff generator.

We have made measurements of solubility, swelling, gas evolution and physical properties on a large number of polymers irradiated with our equipment. These polymers fall into two classes: those that become degraded and those that become cross-linked. The accompanying table lists some of the polymers investigated.

| Polymers becoming cross-linked | Polymers becoming degraded |
|---|---|
| Polyacrylic esters | Polymethyl methacrylate |
| Polystyrene | Polyvinyl chloride |
| Polyesters | Polyvinylidene chloride |
| Nylon | Polytetrafluoroethylene |
| Polyethylene | Polychlorotrifluoroethylene |
| Chlorinated polyethylene | Cellulose |
| Chlorosulphonated polyethylene | Polyisobutylene |
| Natural rubber | |
| GRS | |
| Butadiene-acrylonitrile copolymers | |
| Neoprene-W | |
| Neoprene-GN | |
| Polydimethylsiloxanes | |
| Styrene-acrylonitrile copolymers | |

A number of other polymer mixtures, co-polymers, and polymer–monomer mixtures have also been found to become cross-linked as a result of irradiation. Although the mechanism of the process is not well established in each of the above examples, some general statements covering possible mechanisms can be made. These, however, will be reserved for future publications.

The polymers that were found to become cross-linked appeared to behave as would be generally expected for a cross-linked material. They were no longer soluble in solvents for the unirradiated material; they showed improved form-stability at elevated temperatures; the tensile strength and ultimate elongation changed upon irradiation; and they for the most part changed from plastic to elastic substances.

We have investigated the properties of polyethylene, nylon and polydimethylsiloxane in some detail. During the irradiation of polyethylene, hydrogen was evolved in a quantity found to be proportional to the amount of irradiation. These results have been compared with our solubility and swelling results, analysed by the methods of Flory[5] and Flory and Rehner[6], and indicate that the number of cross-links was also proportional to the amount

of irradiation. Hydrocarbon compounds up to $C_{11}$ were evolved during the process. Definite changes in the infra-red spectrum have been noted. The optical density at 5·8 μ was approximately proportional to the amount of irradiation.

Polyethylene samples covering the range of reported molecular weights from 2,100 to 24,000 have been irradiated. The amount of irradiation necessary to cause insolubility was found to vary inversely as the 1·26 power of the molecular weight. A sample of paraffin wax required the high dose of 800–900 million röntgen units to convert it into an insoluble rubber-like material. This is approximately the dose predicted from the extrapolation of the above molecular weight – solubility studies.

The effects of temperature and rate of irradiation have been investigated. No change in cross-linking efficiency, as determined by swelling measurements, could be observed over the range of irradiation temperatures from − 74° C. to + 193° C. Likewise, no differences could be observed between samples which had been irradiated with 30 million röntgen units during 1 min. or 30 min. Apparently this process is somewhat different from the free radical polymerizations reported earlier[7], where the results were sensitive to dose-rate and temperature.

Both the tensile strength and the ultimate elongation of polyethylene showed an initial increase with irradiation followed by a slow decrease at high doses. The rate of decrease for ultimate elongation, however, was greater than it was for tensile strength. The initial improvement in both was more marked for the lower molecular weight samples.

The nylon and polydimethylsiloxane samples behaved somewhat similarly to polyethylene. Again the amount of cross-linking appeared to be proportional to the amount of irradiation, the physical properties changed, and the solubility was affected. The efficiencies for cross-linking varied widely from polymer to polymer.

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## Electrical Properties of Chromium Oxide – Alumina Catalysts

Some examples of relations between the activity and the electrical conductivity of catalyst surfaces have been described, notably by Garner, Gray and Stone[1] for copper and copper oxide films. Measurements with a similar degree of accuracy have not been recorded for precipitated catalysts. Experiments with mixed molybdenum oxide – silica ($MoO_3$–$SiO_2$) catalysts, in this laboratory, were discontinued because of the unavoidable presence of metallic molybdenum in such preparations[2].

We have now investigated the electrical conductivity and thermoelectric potential of coprecipitated chromium oxide – alumina ($Cr_2O_3$–$Al_2O_3$) catalysts. The test specimens take the form of a small disk 1 mm. thick and 9·5 mm. in diameter, made by compression of the catalyst into a glass cell after reduction of the finely powdered solid in hydrogen and without exposure to air. Contacts are made by platinum disks welded to platinum wires, and small thermocouples are attached to each face. The conductivity is measured by determining the residual charge in a condenser after leakage through the specimen for a known time. The thermoelectric potential is measured by charging a small condenser from the heated specimen, and then discharging it through a ballistic galvanometer.

Results for conductivity of 70 per cent chromium oxide – 30 per cent alumina after reduction in hydrogen at 500° for 50 hr. followed by evacuation were fully reversible in the range 200°–500°, and satisfied equations of the type $\sigma = A \exp(-\varepsilon/KT)$. On plotting $\log \sigma$ against $1/T$, two intersecting straight lines resulted, as shown in Fig. 1. The conductivity increased in hydrogen, and also when the sample was heated at 500° in oxygen; the oxide may therefore be termed an amphoteric semi-conductor. The thermoelectric potential of the catalyst after reduction in hydrogen varied, as shown in Fig. 2, the hot face being positive. It is clear that the oxide is an electron-excess semi-conductor, unlike chromium oxide in its normal state[3]. This is not in accordance with earlier statements on chromium oxide after treatment with hydrogen. Specimens of the catalyst heated in air at 500° show a reversal of potential.

One fully reduced specimen, exposed to air after cooling to room temperature, but reheated in hydrogen after packing into a cell, was used for determination of the Hall coefficient by the Telecommunications Research Establishment, Great Malvern, using an alternating magnetic field at 50 c./s. and a primary

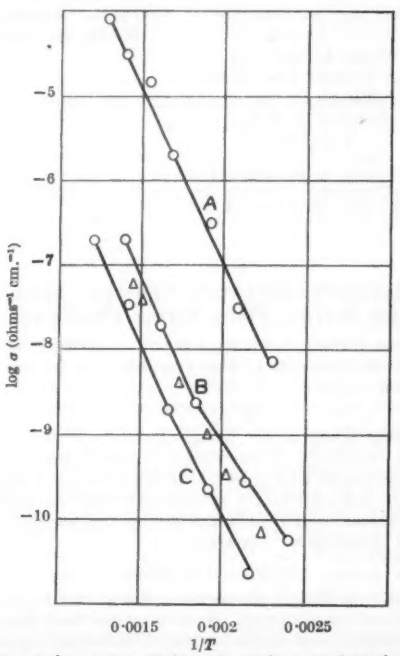


Fig. 1. *A*, in oxygen; *B*, in hydrogen (Δ, second specimen); *C*, in vacuum

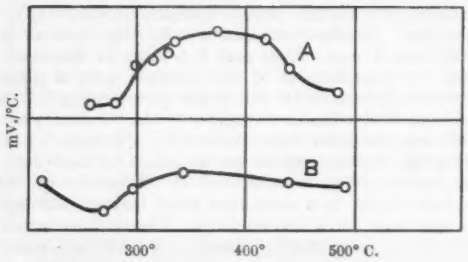


Fig. 2. *A*, in hydrogen; *B*, in oxygen

current at 60 c./s., and measuring the induced 10 c./s. current. This gave a value of $1{\cdot}77 \times 10^5$ cm.$^3$/coulomb for the coefficient of an electron-excess semi-conductor at 442°. The conductivity of this specimen was $1{\cdot}1 \times 10^{-5}$ ohm$^{-1}$ cm.$^{-1}$. We are greatly indebted to Mr. D. A. H. Brown for his interest and participation in these measurements.

These preliminary results indicate that such methods for examining mixed catalysts offer considerable promise, but that great care is essential in the preparation and handling of specimens. In the present series, the semi-conducting properties begin to be measurable in the same temperature-range as the activity for dehydrogenation of heptane and for chemisorption of hydrogen on the clean catalyst. It therefore seems possible that the centres concerned in chemisorption are the same as those responsible for electrical conductivity. If this were so, the activation energies for the two processes should be closely related, and measurements are being continued to investigate this point.

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## A Resistance-Network Analogue Method for solving Plane Stress Problems

Plane stress problems can be described by the Airy stress function $\chi$, which satisfies the biharmonic equation

$$\nabla^4\chi = 0, \qquad (1)$$

the stress components being the second derivatives of this function. A resistance network method has been developed which solves the biharmonic equation.

As has been shown by several authors[1-3], a network of interconnected resistances solves the second-order partial differential equation

$$\nabla^2\chi(x,y) = \Phi(x,y), \qquad (2)$$

the function $\Phi(x,y)$ representing the current fed into the network node $(x,y)$. Now suppose that $\Phi(x,y)$ is the solution of a second-order equation,

$$\nabla^2\Phi(x,y) = f(x,y), \qquad (3)$$

where $f(x,y)$ is a known function of the co-ordinates $x$ and $y$. Then obviously

$$\nabla^4\chi(x,y) = f(x,y). \qquad (4)$$

To establish the solution of equation (4), one need only connect two identical resistance networks in cascade by joining corresponding nodes in the two networks by (relatively) high-value series resistances, and feed in currents at the 'upper' network corresponding to $f(x,y)$, while applying the boundary conditions appropriate to $\Phi(x,y)$ at the 'upper' network. The voltages $\Phi(x,y)$ then appearing in the 'upper' network, and representing the 'solution' of equation (3), constitute the sources for the currents fed into the 'lower' network, the currents being proportional to these voltages. Hence, equation (4) is satisfied by this network arrangement. This principle might be extended to the solution of partial differential equations of higher even orders, but practical difficulties arise through the potential division in the network cascades, and the ensuing low signal-level in the 'lowest' network. This particular difficulty makes itself already felt in the network cascade to solve the biharmonic equations (1) or (4), because relatively high accuracy in the determination of the $\chi$ function (a few parts in 10,000) is required, in order that the stress components can be obtained with an accuracy of 1–2 per cent by numerical differentiation of the measured $\chi(x,y)$ values. However, this accuracy has now been achieved in an experimental apparatus set up to test the practicability of the method.

Another difficulty is that usually unfavourable boundary conditions are specified, for example, $\chi_B$ and $(\partial\chi/\partial n)_B$, which correspond to the case of 'ill-conditioning' in numerical methods of solving equation (1)[4]. This has been overcome by setting up one of the boundary conditions, for example, $(\partial\chi/\partial n)_B$, and displaying (on a cathode ray oscillograph screen) the other one, $\chi_B$, simultaneously for all boundary points. The boundary values of the $\Phi$ function (at the 'upper' network) are then adjusted until the observed $\chi_B$ values have their prescribed values within specified limits. This mode of operation is, to some extent, the experimental counterpart of Southwell's relaxation method[5], but the networks are 'self-relaxing' in their interior[3], and the error signals along the boundaries are all simultaneously in view. Hence, although the problem is 'ill-conditioned', a solution of sufficiently high accuracy can usually be established in a relatively short time; for example, present experience has shown that in a typical case, with a total of about 250 mesh points, and twenty-five displayed boundary points (the other boundary points having fixed boundary values), the solution can be established in less than half an hour to within 3 parts in 10,000. Of course, the extraction of the full information and the evaluation of the stresses at all mesh points takes much longer.

A more detailed account of the method and its experimental realization will be published elsewhere.

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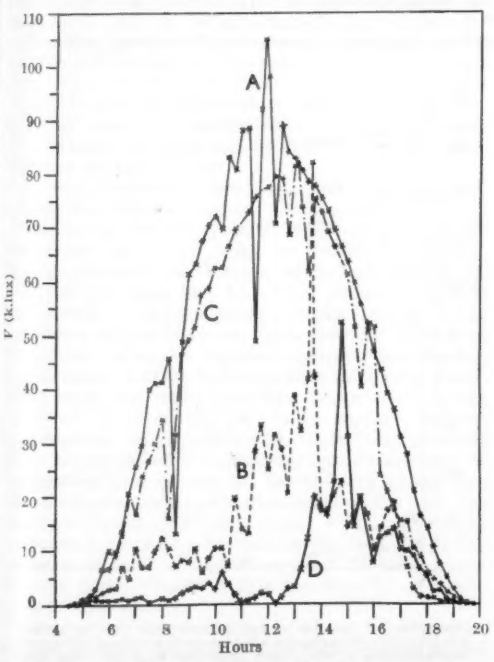
## Reduction in Light accompanying Exceptionally Heavy Rain

We are indebted to Prof. J. H. J. Poole for the suggestion that our record of illumination during very heavy rain last August might be worth studying further. We accordingly compared the data for sunshine, rainfall until 3 p.m., maximum vertical illumination in kilolux and the illumination integral in kilolux-hours for four days: August 10, clear and sunny; August 11, completely overcast sky until about 11 a.m. G.M.T.; August 14, clear and sunny; and August 15, exceptionally dark and wet until about 1 p.m. The Lynmouth flood was occasioned by the rain of August 15, falling rather later in that district.

The accompanying graph shows kilolux plotted against time, based on measurement of the charts, obtained with a Burt vacuum sodium cell and Cambridge thread recorder[1]; for reproduction the minute-by-minute dots were replaced by quarter-hour readings, but in addition maxima and minima were included. The original chart, with current shunted to 0·2 for summer use, could be read to 0·1 scale division, corresponding to 0·35 kilolux, approximately half the vertical illumination immediately before the first appearance of the sun's disk at sunrise. One's visual impression was that at the minima, 11 a.m. and at 12.15 p.m. on August 15, the illumination was much below this; in a south window, reading was possible but not comfortable.

The high values of $V$ maximum, even on the overcast days, were due to momentary clearings in the afternoon, though the Plymouth Hoe sunshine card showed no sun on August 11 and 15.

It has been shown[2] that considerable thicknesses of unbroken high cloud may still allow an apparent




The ordinates show the vertical component of the illumination from sun and sky, in kilolux. The abscissæ show time of day. Curves *A*, August 10; *B*, August 11; *C*, August 14; *D*, August 15

Plymouth Hoe Observations

| 1952 | Sun (hr.) | Rain (mm.) | $V$ max. (k.lux) | K.lux-hr. | K.lux-hr. 4.45 until |
|---|---|---|---|---|---|
| Aug. 10 | 11·12 | 0 | 105 | 630 | |
| 11 | 0·0 | 4 | 82 | 198 | 39 (10.30) |
| 14 | 9·12 | 0 | 82 | 582 | |
| 15 | 0·0 | 82 | 52 | 96 | 13 (13.00) |

percentage transmission of 35–40, though 1,000–2,000 ft. of low stratus may cut the light to 20–35 per cent around noon. But lofty cumulus or cumulonimbus cloud, with tops emergent above the total cover of the lower layers, may reduce the apparent percentage transmission to between 6 and 12 per cent if their bases are low. Unrecorded thicknesses in thunderstorms have reduced transmission to about 1 per cent. The thick cloud on August 11 reduced transmission to 8 per cent about 10.30 a.m., but on August 15 it sank at times to 0·5 per cent or less, and the integrated illumination 13 k.lux-hr. up to 1 p.m. was approximately 4·5 per cent of that for a clear day up to noon. The darkest day we have on record was November 29, 1934, which drizzled to about 0·7 k.lux at 11 a.m. and for the whole day had 14·5 k.lux-hr.

Since most of the water in the towering clouds indicated by the very heavy reduction in daylight must have come in from the Atlantic with relatively little smoke pollution, it is probable that reflexion from the sides and the exit from the column of scattered sunlight accounts for by far the greater part of the loss of light. Such a loss of scattered light could not occur where the sun's rays fall on a level surface of cloud.

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Pamela G. Jenkins

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Plymouth. Jan. 21.

[1] Atkins, W. R. G., and Poole, H. H., *Nature*, **125**, 305 (1930).
[2] Atkins, W. R. G., *Quart. J. Roy. Met. Soc.*, **77**, 659 (1951).

## Albumin: an Unsuspected Physiological Activity

When testing various fractions of human blood plasma prepared by ether precipitation in the cold[1], it was found that albumin had a definite effect on the perfused rabbit's heart. In view of this, and the fact that albumin has been used for clinical transfusion for some years without any evidence of ill effect, the reaction has been studied in some detail.

Both albumin issued for clinical use (96 per cent pure) and albumin of 100 per cent purity as established by electrophoretic and ultra-centrifugal measurements have been used. If a dose of 0·3–0·5 ml. of a 3–6 per cent solution of albumin in saline (*p*H 7·2) is introduced into the Ringer–Locke solution proximal to the cannula of a Langendorff rabbit-heart preparation, the following is observed. The amplitude of the ventricular beat is immediately considerably reduced; this may, or may not, be accompanied by a slowing of the heart. The coronary flow is definitely increased for a short time and is then sometimes decreased. With a dose of 0·3 ml. of 3 per cent 'pure albumin', the duration of the whole effect is about thirty seconds, after which time both the beat and the coronary flow have returned to pre-injection levels. Full atropinization does not affect the result. The change in coronary flow is not due to the alteration in heart beat, for a similar change occurs in the

fibrillating heart. There is no alteration in the electrocardiogram. The changes are not due to an osmotic effect, a slight diminution of amplitude and a slowing in coronary flow being observed after the injection of 0·5 ml. of 6 per cent 'Dextran' saline.

Similar effects are observed in the perfused guinea pig's heart, but no change occurs in the beat of the intact guinea pig's heart when the albumin is injected directly into the left auricle[2], even when 0·5 ml. of 16 per cent pure albumin solution is rapidly injected. Albumin has also been injected into the auricle of animals which have been repeatedly bled and the loss made good by the transfusion of 'Dextran'; 0·5 ml. of 12 per cent pure albumin is without effect when the hæmatocrit has fallen to a value of 10 per cent red cells. As would be expected, there is no immediate change in carotid blood pressure when the albumin is rapidly injected into the jugular vein of the intact or bled guinea pig in which the loss has been made good with 'Dextran,' the result being a gradual rise in blood pressure.

In the method of intra-auricular injection, the dose floods the left side of the heart and passes rapidly through the coronary arteries, and the reason why the albumin is without effect even in large doses is not understood. If the albumin fraction is dialysed against several changes of saline or water, it is still active though on a somewhat reduced scale. A similar effect is seen with human albumin prepared by the Cohn's ethanol[3] precipitation, and with albumin prepared from horse, sheep, ox and rabbit blood by ether-alcohol precipitation.

The fact that albumin prepared from rabbit's blood affects the perfused rabbit's heart in the same way as albumin prepared from other species indicates that it is not a foreign protein effect. The lipoproteins and the gamma globulins are devoid of this particular activity.

The action of albumin upon the isolated rabbit's or the guinea pig's gut is variable. On some occasions there is an abrupt relaxation, while on others there is a constrictor effect, or there is little or no effect. In the perfused rabbit's ear, an injection of 0·5 c.c. is followed by an increase in flow.

The physiological effects observed are consistently associated with albumin, but the criteria of purity does not preclude the possibility that they are in fact due to some smaller molecule associated with it.

From these experiments it would seem extremely unlikely that the reaction seen is of any practical significance in blood transfusion, where the introduction of albumin is much slower. This is borne out by the absence of any clinical ill effect, even where albumin is transfused rapidly as a 25 per cent solution. The use of albumin experimentally, however, might well show up effects which would fall into line with our results.

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April 27.

* Working on behalf of the Medical Research Council.

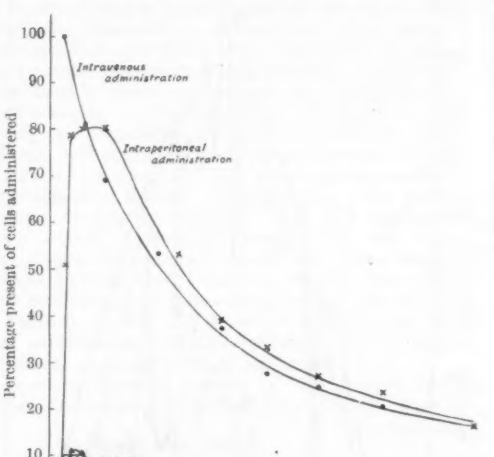
[1] Kekwick, R. A., and Mackay, M. E. (to be published).
[2] Drury, A. N., Lutwak-Mann, C., and Solandt, O. M., *Quart. J. Exp. Physiol.*, **27**, 215 (1938).
[3] Cohn, E. J., Oncley, J. L., Strong, L. E., Hughes, jun., W. L., and Armstrong, jun., H. S., *J. Clin. Invest.*, **23**, 674 (1944).

## Studies with Erythrocytes labelled with Radioactive *p*-Iodophenylhydroxylamine

A technique has been developed in this laboratory for the rapid labelling of erythrocytes *in vivo* and *in vitro* using *p*-iodophenylhydroxylamine ($I.C_6H_4.NH.OH$) containing radioactive iodine. This compound, together with its green oxidation product *p*-iodonitrosobenzene ($I.C_6H_4.NO$), has a remarkable affinity for hæmoglobin, and in spite of its insolubility in water rapidly penetrates red cells and combines firmly and stoichiometrically with the cell pigment[1]. The reaction with hæmoglobin and some of its derivatives has been examined in detail and appears to be irreversible so long as the hæm molecule remains intact.

The facility with which the process may be applied to cells has made possible a detailed study of the rate of turnover of erythrocytes in several mammals (rat, mouse and dog) and in hens; it should be applicable to all animals possessing hæmoglobinated corpuscles. During the course of this work when the validity of the technique was being established, it was found that labelled red cells were rapidly absorbed from the peritoneal cavity of the rat, and this observation has since been extended to the mouse and dog. In the rat, in which the most detailed studies have so far been made, it has been shown that the cells retain the viability of the same cells administered intravenously (see graph).

In this experiment about 10 per cent of the radioactivity administered as cells by the intraperitoneal route appeared in the urine within 24 hr., and a similar quantity of activity was found in the spleen. It must be emphasized, however, that the amount of iodophenylhydroxylamine associated with the cell in this case had to be great enough to enable the disappearance of cells from the blood to be followed for an adequate period of time, limited as it is by the relatively short half-life of the radioactive




Comparison of the fate of red cells labelled with radioactive *p*-iodophenylhydroxylamine after intraperitoneal and intravenous administration to rats. Each point represents the mean result for five animals (200 gm. weight) after the same dose of cell suspension (= 0·5 ml. blood per animal; label equivalent to 90 μgm. *p*-iodophenylhydroxylamine/ml. cell suspension)

iodine. The magnitude of the cell label has an important influence on the survival-time of the cells.

Full reports on the various aspects of this work will be published elsewhere; meanwhile the mechanism of absorption of cells from the peritoneal cavity and the application of this technique to the human subject are being investigated.

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[1] Crick, J., and Jackson, H., *Brit. J. Pharmacol. Chemother.*, **7**, 142 (1952); and also in the press.

## 'Sex-Ratio': a Non-Mendelian Character in *Drosophila bifasciata*

ON three independent occasions an exceptional trait has been recovered in collections from Nature of females of *D. bifasciata*: in Pavia in 1943 [1] and 1947, and in Mergozzo (Lago Maggiore) in 1947. This trait expresses itself in an abnormal sex-ratio of offspring from females mated to any type of male. By analogy with previously described cases[2], the character has been designated as 'sex-ratio'. The strain used in the experiments discussed here originated from the 1947 collection in Pavia. The behaviour of this stock can be summarized as follows.

(1) Sex-ratio females produce on an average only 0·5 per cent males, while normal females produce about 47 per cent males. The sex-ratio strain can be maintained only by crossing any females originating from sex-ratio mothers with normal males of the same species. The source of the flies used as male parents has no effect on the transmission of the abnormal sex-ratio, as shown by tests of five geographically different strains (including one of Japanese origin).

(2) The percentage of males has not varied significantly throughout five years with two important exceptions, noted below, when it was raised ten-fold.

(3) The trait is transmitted only by females (and by all of them) originating from the cross sex-ratio ♀♀ × normal ♂♂, and not by any of the rare male offspring of such a cross.

(4) Only somewhat less than half the eggs laid by sex-ratio females hatch.

The more obvious genetic explanations of the exceptional behaviour may be readily ruled out. Thus spontaneous parthenogenesis is excluded by the fact that the eggs laid by virgin sex-ratio females are infertile. Parthenogenesis induced by sperm or copulation is similarly excluded because it can be shown that in crosses between sex-ratio females and normal males with suitable markers (including a sex-linked one) the male genotype contributes to the genotype of the offspring in a regular fashion. Explanations resting on sex-linked lethals, attached X-chromosomes, and non-disjunction phenomena or chromosome aberrations can be ruled out by the fact that the above-described transmission of the trait has persisted unchanged for more than eighty-one generations, produced by mating the females of the line with normal unrelated males. It thus seems that the genetic basis of this character is of extra-chromosomal nature.

The unusual determination of the trait is further demonstrated by the fact that sex-ratio females laying eggs at the raised temperature of 26° C. produce an approximately normal sex-ratio among their offspring. This thermal 'cure', however, is not permanent, since when such females are returned to the normal temperature of 21° C., they revert to their original behaviour, that is, their eggs containing putative males fail to hatch. The temperature at which the male mates of the sex-ratio females under heat treatment have been reared has no effect on the sex-ratios produced. Furthermore, temperature treatment of virgin sex-ratio females is ineffective. It seems that the effect of the heat treatment is exercised in the time interval between the last hours of maturation of the eggs and the first 12–18 hours of zygote development. It is worthy of note that the two 'cases' of spontaneous 'cures' mentioned above occurred when the room temperature at which the flies were kept rose suddenly to about 25° C. (once in the summer of 1951 and once in March 1952).

The offspring of temperature-cured sex-ratio mothers differed in their behaviour according to treatment. Those originating from zygotes kept at 26° C. only prior to pupation produced 17–19 per cent males in their progeny, irrespective of the length of the treatment (1–12 days). Those kept at 26° C. until after emergence produced 39 per cent males. It would thus appear that a second temperature-sensitive period exists during the pupal stage.

These results were obtained from mass cultures. Experiments on single fly cultures from treated females showed that the percentage figures quoted resulted from variable behaviour of individual females: some produced normal sex-ratios, some behaved in the manner typical for the sex-ratio strain, and others gave intermediate results. Granddaughters of treated females continued to segregate, that is, normal, intermediate and sex-ratio females were recovered from all three categories. Only one case of an apparently permanent cure was observed, which in the fifth generation is still producing offspring with a normal sex-ratio.

These observations suggest that a genetic unit, possibly carried in the cytoplasm, exists in sex-ratio females and is transmitted only through eggs. This unit is responsible for the early death of *XY* zygotes, when present in a threshold concentration. High temperature inhibits or partially inactivates it, thus decreasing the probability of its presence in *XY* zygotes in amounts above the threshold. The complete data will be presented in another publication.

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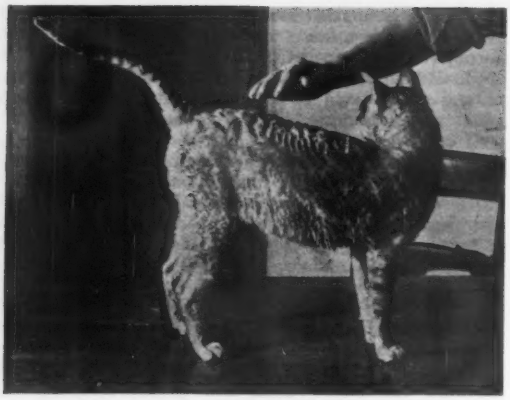
Istituto di Genetica, Università, Pavia. Feb. 4.

[1] Buzzati-Traverso, A., D.I.S. No. 14, 49 (1941).
[2] Morgan, Th., Bridges, C. B., and Sturtevant, A. H., *Bibliograph. Genetica*, **2**, 1 (1925).

## A 'Rex' Mutant in the Cat

IN the house-mouse, five genes are known with much the same action on the fur: shortening the guard-hairs, curling the whiskers, and making the baby coat (sometimes the adult too) wavy[1]. Three recessive genes in the rabbit, rex–1, rex–2, and rex–3, affect guard-hairs and whiskers as in the mouse mutants; the fur is not wavy, however, but is short and plush-like. There are also similar mutants in the rat[2].

A similar 'rex' type of mutant has now turned up in the cat (see accompanying photograph). The fur of affected kittens is wavy; later it becomes very woolly to the touch, just like a young rex rabbit. The adult hair is curly but has the velvet texture of



Original male mutant of 'rex' coat-type in the cat

the rex rabbit; the whiskers are curled. The original mutant (a male which also carries the sex-linked gene for yellow hair colour) has been mated to his tortoise-shell mother. Seven kittens have been produced so far, of which three have been rex. So the condition is inherited; but it is not yet possible to tell whether as a recessive or a dominant.

It is hoped to publish further details later.

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3 Hill View Road, Mapperley,
Notts. May 23.

[1] Grüneberg, H., "The Genetics of the Mouse" (Martinus Nijhoff, 1952).
[2] Grüneberg, H., "Animal Genetics and Medicine" (Hamish Hamilton, 1947).

## Inhibition of Superovulation in the Rabbit

The horse pituitary extract *AP*.118.*B* induces superovulation in albino does at 12 weeks of age, provided the animals are fed at a high level from birth. Treatment consists of six subcutaneous injections of this pituitary extract at 12-hr. intervals, followed by an intravenous injection of 25 I.U. prolan 12 hr. later. When this treatment was repeated in the same does at 28-day intervals, in 95 per cent of the experiments the ovarian response was poor and ovulation did not occur. Ovulation did occur at sexual maturity, but only the normal number of ova was shed.

Parkes[1] found that a 10-day as opposed to a 5-day treatment with horse pituitary extract caused a decrease in ovarian stimulation in adult albino does, which suggested that the formation of antibodies might be very rapid.

On the basis of these observations, it was thought possible that the transfer of plasma from a pituitary-treated doe to an untreated one might inhibit ovarian response when the latter was afterwards treated with the same preparation. The results of experiments to test this possibility (see table) suggest that citrated plasma from a doe treated with the horse pituitary extract *AP*.118.*B* has this inhibiting power.

This work, which was carried out during the tenure of an Agricultural Research Council studentship, will be described in detail elsewhere. I wish to thank Dr. A. S. Parkes for making available the preparation *AP*.118.*B*, and Dr. John Hammond and Lord Rothschild for advice and encouragement.

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Jan. 22.

[1] Parkes, A. S., *J. Endocrinol.*, **3**, 268 (1942).

| Rabbit No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Treatment | P and M (84, 112, 140, 168) | P and M (112, 140, 168, 196, 360) | | P and M (84) (No ovulation) | | | |
| | Plasma to No. 7 (322) | Plasma to No. 3 (367) | Plasma from No. 2 (110) | | Plasma to No. 6 (100) | Plasma from No. 5 (83) | Plasma from No. 1 (83) |
| Result of final treatment (number of ovulations) | P and M (338) | | P and M (116) | P and M (116) | P and M (116) | P and M (99) | P and M (99) |
| Less than 10 | Yes | Yes | Yes | No | No | No | No |
| More than 20 | No | No | No | No | Yes | Yes | No |

P, treatment with *AP*.118.*B*; M, mating. Age in days at the beginning of each treatment is given in brackets.

## Polyspermy in Mammals

Polyspermy—the entry of more than one sperm into the vitellus at fertilization—is commonly regarded as a pathological process in mammals, with the implication that it leads to early degeneration of the embryo, and this opinion has been expressed by such authorities as Lams[1], Wilson[2], and Hartman[3]. In fact, very little is known concerning polyspermy in mammals, and data on its incidence or consequences are lacking. A study has therefore been made of polyspermy in the rat and rabbit, and a brief account of the results is presented in this communication. A full report is being prepared for publication elsewhere.

In the initial experiments, adult virgin female rats were permitted to mate under normal colony conditions by being placed with males in the afternoon and left with them overnight. Mated rats were recognized by their having a copulation plug when examined the following morning. Sixty-eight mated rats obtained in this way were killed during the day and the eggs recovered for examination in the fresh state with a phase-contrast microscope. These rats provided a total of 627 eggs, of which 614 (97·9 per cent) had been penetrated by sperms. Nine of the penetrated eggs, or 1·5 per cent, were polyspermic; in each of these, one extra sperm had entered the vitellus. The polyspermic eggs were in various stages of fertilization when examined; in two eggs the sperm heads were undergoing metamorphosis and pronuclei had not yet formed, but both midpieces and both acrosomes could be distinguished as they lay in the egg cytoplasm. The remaining polyspermic eggs were in different stages of pronuclear growth, and in each one the extra sperm midpiece and the extra pronucleus were clearly seen. It was noticeable that the two male pronuclei were almost identical in size and appearance.

In the light of previous (unpublished) observations, it was decided to test the effect of delayed mating upon the incidence of polyspermy. Between 8.0 and 9.0 a.m., rats that showed an œstrous smear were selected, and it was known[4] that in such animals ovulation had probably taken place between midnight and 4.0 a.m. the same morning. These animals were placed with males from 9.0 to 10.0 a.m. and were then examined for the copulation plug. Those with plugs were killed at 9.0–11.0 a.m. the following day.

From thirty of these rats a total of 265 eggs was obtained, of which 237 (89·4 per cent) had been penetrated by sperms. Of the penetrated eggs, 22 (9·2 per cent) were polyspermic. These polyspermic eggs either showed the later stages of pronuclear growth or the formation and mitosis of the first segmentation spindle, or else had completed the first cleavage and were in the 2-cell stage. Pronuclear stages were similar to those seen in polyspermic eggs from rats mated at the normal time: two male pronuclei were present in each egg and they were almost identical in appearance. In nine of the polyspermic eggs the chromosomes in the prophase or metaphase of the first segmentation mitosis were visible; in each egg only a single group of chromosomes could be found. Seven of the polyspermic eggs had undergone the first cleavage and were apparently quite normal except for the presence of a second midpiece in the cytoplasm of the blastomeres. As there were no pronuclei in the eggs in the last two groups, diagnosis of the polyspermic state depended upon the finding of two sperm midpieces within the vitellus and the recognition of the early signs of disintegration in these midpieces. This evidence is readily appreciated and aids in the distinction between sperms that have entered the vitellus of the egg and 'supplementary' sperms that have only penetrated the zona pellucida.

In a further experiment, eighteen rats which had been induced to mate after ovulation, at 9.0–10.0 a.m., were not killed until three days later. Five of these rats yielded six polyspermic eggs, four 4-cell and two 8-cell, which appeared normal in all particulars except for the presence of the extra sperm midpiece. Both the sperm midpieces were clearly within the cytoplasm of the blastomeres and showed the degree of disintegration that is seen in the monospermic 4-cell and 8-cell eggs.

Polyspermy is more difficult to diagnose in rabbit eggs, for it has not been found possible to identify the sperm midpiece within the vitellus, although sperms may readily be discerned with the phase-contrast microscope in the perivitelline space. Diagnosis, therefore, could only be made on the finding of three or more pronuclei within eggs which were otherwise normal in appearance. Eight female rabbits were permitted to mate and were killed 16–19 hr. later. From these animals, 57 eggs were obtained of which all showed evidence of sperm penetration but three had no pronuclei. Of the remainder, 53 had two pronuclei each and one was classed as polyspermic: the latter had three structures resembling pronuclei, though they were not very clearly discernible.

In a second group, thirteen female rabbits received an intravenous injection of chorionic gonadotrophin for the induction of ovulation, and were allowed to mate 10 hr. later, that is, at about the time of ovulation. The rabbits were killed 12–13 hr. after mating and a total of 85 eggs was recovered from them for study; 62 eggs showed evidence of sperm penetration, but in only 47 could pronuclei be seen. Eight eggs, 17 per cent of those with pronuclei, were judged to be polyspermic; seven had three separate and well-formed pronuclei and one had six structures resembling pronuclei of various sizes.

We conclude, therefore, that if polyspermic eggs degenerate during subsequent development, the greatly increased incidence of polyspermy which results from delayed mating may well be of importance in animal breeding practice. All the polyspermic rat eggs observed had been penetrated by one extra sperm and the evidence obtained points to both sperms playing their part at syngamy and thus contributing their complement of chromosomes to the zygote. Polyspermy could thus be a source of triploidy in the mammalian embryo, and some instances of the 'spontaneous' triploidy observed by Beatty and Fischberg[5] in mouse embryos may be referable to the same cause.

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Dec. 22.

[1] Lams, H., *Arch. Biol.*, **28**, 229 (1913).
[2] Wilson, E. B., "The Cell in Development and Heredity" (Macmillan Co., N.Y., 1925).
[3] Hartman, C. G., in "Sex and Internal Secretions", edit. by E. Allen (Williams and Wilkins Co., Baltimore, 1932).
[4] Austin, C. R., and Braden, A. W. H. (In preparation).
[5] Beatty, R. A., and Fischberg, M., *J. Genetics*, **50**, 345 (1951).

## Absence of a Lansing Effect in *Drosophila subobscura*

Lansing[1] has conducted experiments to show the effect of maternal age on the length of life of the parthenogenetic rotifer *Philodina citrina*. The median length of life of the 'wild' strain of this species was 21–24 days, and maximum length and the adult rate of egg production were reached on the sixth day of life. A strain was bred from this wild strain consisting of rotifers hatched in each generation from eggs laid on the fourth day of parental life. Other strains were established, with parental ages in each generation of eleven and of sixteen days. In the fourth-day strain, the mean expectation of life increased over several generations, and the age of attaining the adult rate of egg production was delayed. In the eleventh- and sixteenth-day strains, there was a rapid decrease in the mean expectation of life, the strains reaching extinction in five and three generations respectively. According to Lansing, longevity progressively declines in any strain which is maintained in each generation from eggs laid on or after the sixth day of life. Results similar to those given by *Philodina* were also obtained by Lansing with *Euchlanis triquetra*.

The rotifers are in very many respects biologically unrepresentative. In an attempt to see whether any comparable effect could be detected in an organism of an entirely different reproductive pattern, we have raised and followed through eight generations a stock of the fruit fly *Drosophila subobscura*, in which each generation was hatched from eggs laid after the thirtieth day of imaginal life.

Flies of the structurally homozygous Küssnacht strain were mated at random within 24 hr. of eclosion and kept in pairs in vials, with frequent transfers, until the thirtieth day, when the survivors were transferred to breeding bottles and their progeny reared. Life tables were constructed for each generation. From analysis of these the following mean expectations of imaginal life were calculated.

| | Number of flies in sample | Mean expectation of life from eclosion (days) | Sampling error of mean (days) | S.D. |
|---|---|---|---|---|
| $F_1$ | 72 | 23·95 | 1·15 | 9·65 |
| $F_2$ | 77 | 24·18 | 1·15 | 10·12 |
| $F_4$ | 95 | 22·31 | 1·18 | 11·55 |
| $F_6$ | 129 | 24·69 | 0·877 | 10·13 |

From these results it would appear that there is no significant change in the longevity of *Drosophila subobscura* bred for eight generations exclusively from flies older than thirty days from eclosion.

In his publications, Lansing relates the appearance of the maternal age effect to the cessation of parental growth, which represents, in the rotifer, only the cessation of increase in volume, since no further nuclear division within the syncytium takes place after hatching[2]. A maternal age-effect related to growth-cessation might be expected to be absent in an organism such as *Drosophila*, where metamorphosis is complete, although Alpatov and Pearl[3] found that factors affecting the rate of larval growth also affect the longevity of the imago. *P. citrina* lays about twenty-five eggs, corresponding to a fixed number of egg nuclei in the ovarian syncytium, and these nuclei are in existence at the beginning of egg laying[2], whereas in *Drosophila* oogenesis continues in cycles throughout imaginal life[4]. The many unique features of rotifer reproduction have long been the subject of study. It is, however, of special interest to the biology of senescence to know whether Lansing's effect is confined to rotifers. We propose to repeat the study upon a crustacean which grows during a part of its reproductive period.

Grateful acknowledgment is due to Prof. J. B. S. Haldane and to Dr. Helen Spurway for advice and help in the management of *Drosophila subobscura*. I am maintained by a grant of the Nuffield Foundation.

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[1] Lansing, A., *J. Gerontol.*, **2**, 228 (1947); *Proc. U.S. Nat. Acad. Sci.*, **34**, 304 (1948).
[2] Hyman, L. H., "The Invertebrates", **3**, 99 (McGraw-Hill, New York, 1951).
[3] Alpatov, W. W., and Pearl, R., *Amer. Nat.*, **63**, 37 (1929).
[4] Stolfi, J. E. (1938), in Miller, A., "Biology of *Drosophila*", 530 (Chapman and Hall, London, 1950).

## Relaxing Factors in Muscle

According to Szent-Györgyi[1], muscle in the relaxed state is characterized by the dissociation of actomyosin into actin and myosin.

One of us (M. C. G.)[2], using the glycerated fibre preparation[1] of rabbit psoas muscle, has confirmed this by showing that ionic media which produce dissociation of actomyosin[3] cause a reduction in elastic modulus of the fibres under isometric conditions, although in all these cases the conditions are unphysiological. Elastic modulus here is a well-defined quantity, well-washed and preserved fibres having Hookean elasticity which corresponds to the value found by Hill[4] for intact muscle in tetanus, and is some five times greater than for the same muscle in the resting state. An alternative proof is given by the temperature dependence of tension (Varga[5]). Fibres under isometric tension in the presence of adenosine triphosphate are relaxed by reducing the temperature, actomyosin formation being an endothermic reaction, and there is also a corresponding reduction in elastic modulus as measured by quick stretch or release.

The question was then: What makes a reversible dissociation under physiological conditions? Attempting to answer this, it was found that a watery extract (1 : 1 by weight) of fresh muscle mince contained a factor which, in presence of adenosine triphosphate (4 m*M*), has a powerful dissociating action, judged by complete relaxation of the fibre, and fall of elastic modulus, although the total ionic strength was only 0·05 *M* (adenosine triphosphate only dissociates at ionic strength greater than 0·25). Further, this action was reversible with *p*H, the range 6·0—7·5 sufficing for complete relaxation and contraction respectively.

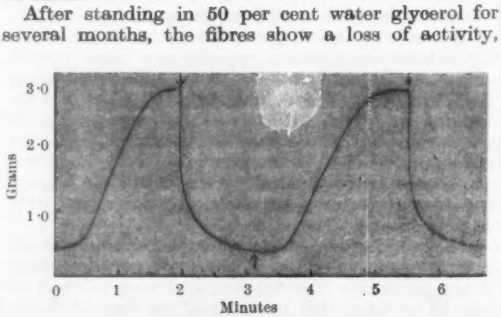
We then began a systematic investigation of this factor from muscle extract using the *p*H dependence of isometric tension of glycerated fibres as a quantitative method of assay, the variation of *p*H being made by a current of carbon dioxide or nitrogen alternately, and the percentage relaxation from maximum tension being taken as measure of activity.

We finally obtained a crystalline substance (as calcium salt from ethanol and recrystallized four times) which was analysed as creatine phosphate and had the following properties: (1) 10 m*M* gives maximal activity; (2) 2 m.equiv. magnesium ions is necessary; (3) 0·8 m.equiv. calcium ions inhibits completely; (4) *p*H range required, 6·2–6·6.

The accompanying record shows a direct record of tension cycle produced in this way with a glycerated fibre bundle. In all tests, 4 m*M* adenosine triphosphate and 1 m*M* magnesium chloride were present, and the ionic strength of potassium was made up to 0·1 $\mu$. Large amounts of magnesium chloride did not antagonize the inhibiting effect of calcium chloride (ratio 100 : 1). Synthetic[6] sodium creatine phosphate gave the same results as the product obtained from muscle. In absence of adenosine triphosphate there was no relaxation or decrease of elastic modulus.

In the absence of creatine phosphate fibres, the *p*H dependence of tension developed by adenosine triphosphate alone (between *p*H 7·5 and 5·8) amounts to 25 per cent, and is established somewhat more slowly[2]. In estimating activity this control should be made.

After standing in 50 per cent water glycerol for several months, the fibres show a loss of activity,




Tension of isometric contraction. ↓, Carbon dioxide, *p*H 5·7; ↑, nitrogen, *p*H 6·6

though their contractility remains unimpaired. By washing with 0·05 *M* sodium bicarbonate – glycerol, the activity was lost entirely in five days at — 20° C. It could be restored by incubation for 30 min. in dialysed muscle extract. This factor *X* appeared repeatedly in the fraction obtained between 50 per cent and 70 per cent saturated ammonium sulphate precipitation, and withstood exhaustive dialysis. We concluded that *X* is probably a protein-enzyme for which creatine phosphate is a necessary substrate.

After long bicarbonate – glycerol washing there was a steady decrease in the speed, though not the maximum tension, of contraction; the speed could be restored by addition of small amounts of cysteine, or of acid-boiled extract which does not contain *X*-factor.

The sharp *p*H dependence of the *X* – creatine phosphate system has special significance for the mechanism of the initiation of the contraction cycle, in view of the *p*H difference 5·8–7·4 estimated by Boyle and Conway[7] which is maintained between the inside and outside of the intact fibre by the membrane. We note here that the work of Marsh[8] and Bendall[9] which reports factors with similar activity makes no reference to *p*H dependence. They appear to agree, however, on the role of divalent ions; in this respect there is also agreement with the work of Bozler[10].

M. C. Goodall
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Jan. 5.

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## *Cryptolæmus montrouzieri* Mulsant in South India

In *Nature* of March 1, 1952, Puttarudriah *et al.*, in reporting the occurrence of *Cryptolæmus montrouzieri* near Bangalore, refer to the lack of information on its introduction into India beyond a statement on an index card in the U.S. Department of Agriculture that an unsuccessful attempt was made in 1898.

In the course of some research into the history of the United Planters' Association of Southern India, which attains its diamond jubilee this year, it has been found that this attempt to introduce *Cryptolæmus* into southern India is well documented, although the documents have been concealed in appendixes to the *Proceedings* of the Association and are therefore not readily available.

At the annual general meeting of the Association in 1896, Mr. H. O. Newport, a planter of the Lower Pulneys (Madura District), raised the question of biological control as a means of dealing with the newly introduced *Coccus viridis* Gr., which was attacking coffee and causing serious alarm, and referred specifically to the work of Koebele in Hawaii. Mr. Newport, an amateur entomologist, had already observed indigenous coccinellids predatory on the *Coccus*, and he pressed the Association to raise funds to organize the introduction of *Cryptolæmus*. In the following year, the Association passed the following resolution: "That this Association do allot Rs. 2,000 from the Reserve Fund to be added to any other sums raised for the purpose of introducing Coccinellidæ into Southern India with the object of combating scale pests. . . . That the Planting Member of Council be instructed to ascertain to what extent the Government of Fort St. George will afford financial assistance. . . . That in the event of a sufficient sum being raised, a qualified person, preferably Mr. Newport, be despatched to Australia and elsewhere to collect and bring back the Coccinellidae". Rs. 6,050 was subscribed, of which Rs. 1,000 came from the Madras Government, and Mr. Newport left India on January 30, 1898, and arrived back towards the end of June with a consignment of some 4,300 adult beetles comprising 2,540 *Orcus australasiæ* Boisd., 1,500 *Cryptolæmus montrouzieri* Mulsant and 246 *Rhizobius ventralis* Erichs. which had been conveyed in ice chests. Subsequent events can best be described in Newport's own words. "Within an hour or so of my arrival there [at his coffee estate in the Lower Pulneys] on the 20th of June, I opened out five of the cases, containing some 2,500 of the lady birds of all three varieties. These I opened out on a cloth on the coffee trees, some in the sunlight and some in the shade. . . . The lady birds, when I turned them out, were mostly clinging to the moss which I had put in the boxes, and they looked healthy enough, only one or two here and there looked seedy. Most of them were full bodied and soft, their legs and antennæ I could move freely with a needle and those that I squeezed were full and moist inside. I could, I regret to say, however, get them to show no signs of life. . . . I had no better success with the second half than I had with the first half consignment".

In the following year, Newport left south India to take up an appointment with the Government of Queensland as instructor in coffee cultivation, so that the matter was not followed up in the area of liberation. There would seem a possibility that eggs or pupæ among the packing could have given rise to viable adults, or some of the apparently dead adults may have survived and escaped observation.

The notation on Dr. Clausen's card files 'Howard 1898' undoubtedly arises from the fact that the Secretary of the United Planters' Association of Southern India forwarded a copy of "Planting Opinion" containing Newport's report on October 5, 1898, and this was acknowledged by Howard on November 7 of the same year.

The combination of depredations by the coccid and a heavy fall in coffee prices led to a considerable decline in coffee growing in the Lower Pulneys, and the local district planters association was wound up in 1899. This, together with Mr. Newport's departure, effectively extinguished interest in this attempted introduction; but it seems that it was more successful than its originator could have dared to hope. The total expenditure incurred on this project was Rs. 4,773, or a little more than £300 at the 1898 stabilized rate of exchange.

W. Wilson Mayne

Scientific Department,
Kanan Devan Hills Produce Co., Ltd.,
Munnar P.O., Travancore, S. India.

# FORTHCOMING EVENTS

## Monday, July 13—Tuesday, July 14

PHYSICAL SOCIETY (in the Department of Physics, King's College, Newcastle-upon-Tyne).—Summer Provincial Meeting on Optics and Ultrasonics.

## Monday, July 13—Saturday, July 18

UNIVERSITY OF BIRMINGHAM (in the Physics Department, The University, Edgbaston, Birmingham 15).—Conference on Nuclear Physics.

## Wednesday, July 15

ROYAL METEOROLOGICAL SOCIETY (at the Building Research Station, near Watford), at 2.30 p.m.—Summer Meeting.

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Symposium on "Salvage and Utilization of Food Waste for Animal Feeding".

## Friday, July 17

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, Bute Medical Buildings, St. Andrews), at 11 a.m.—Scientific Papers.

## Saturday, July 18—Thursday, July 23

PHYSICAL SOCIETY, the INSTITUTE OF PHYSICS, and the ELECTRICAL RESEARCH ASSOCIATION (at the Clarendon Laboratory, Oxford).—Conference on "Ionization Phenomena in Discharges".

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# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR PSYCHOLOGIST IN THE DEPARTMENT FOR CHILDREN AND PARENTS, Tavistock Clinic, 2 Beaumont Street, London, W.1—The Group Secretary, Central Middlesex Group H.M.C., Acton Lane, London, N.W.10 (July 15).

AGRICULTURIST (with science degree, preferably with honours, and aptitude for research work) IN THE FIELD HUSBANDRY BRANCH, Department of Research and Specialist Services, Southern Rhodesia Government—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (July 18).

ASSISTANT, GRADE I (with good honours degree in pharmacy and/or physiology), IN THE DEPARTMENT OF PHARMACY AND BIOLOGY—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (July 18).

ASSISTANT EXPERIMENTAL OFFICER (with general certificate of education (advanced level) or pass degree in biological subjects) IN THE POULTRY RESEARCH CENTRE, Edinburgh—The Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1 (July 18).

DEMONSTRATORS IN MECHANICAL ENGINEERING (with engineering degree or equivalent, and preferably industrial experience)—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (July 20).

CHEMIST (with first- or second-class honours degree or equivalent in chemistry, and at least three years postgraduate research experience, with particular reference to study of corrosion of ferrous and non-ferrous metals) in the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria, to assist in study of effects of tropical conditions on service materials and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.286/53A (July 25).

LECTURER IN PHYSICAL CHEMISTRY—The Secretary to the University, The University, Edinburgh (July 25).

ASSISTANT KEEPER OF BIOLOGY (university graduate or holder of the Diploma of the Museums Association)—The Director, Museum and Art Gallery, New Walk, Leicester (July 31).

RESEARCH ASSISTANT IN THEORETICAL PHYSICS—The Registrar, King's College, Newcastle upon Tyne (July 31).

SENIOR LECTURER or LECTURER IN MATHEMATICS at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 31).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Textile Scientist) (preferably with several years experience in the textile industry, and academic qualifications of honours degree status in textile science, physics or some branch of engineering) IN THE PHYSICS AND ENGINEERING UNIT, Wool Textile Research Laboratory, Sydney, for research into the physical properties of wool fibres or of fibre assemblies, or into the physical principles of textile processes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 465/34 (July 31).

PLANT PHYSIOLOGIST (with sound fundamental training and research experience) for studies on the physiology and metabolism of fruit under storage conditions in relation to orchard factors—The Secretary, East Malling Research Station, Maidstone, Kent (August 1).

TECHNICAL OFFICER (with university degree in science or agricultural science, with botany or plant ecology as a major subject) IN THE LAND RESEARCH AND REGIONAL SURVEY SECTION, Commonwealth Scientific and Industrial Research Organization, Canberra, for ecological studies of native vegetation, as a member of a field survey unit which will also include a geologist, pedologist and geomorphologist—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 570/19 (August 1).

PRINCIPAL RESEARCH OFFICER (with at least an M.Sc. degree in mechanical engineering or its equivalent, and not less than eight years' practical and/or research experience in mechanical engineering) IN THE MECHANICAL ENGINEERING RESEARCH UNIT, South African Council for Scientific and Industrial Research, Pretoria, to undertake research work connected with technical problems in the field of mechanical engineering and particularly fluid mechanics and its applied fields—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, August 8).

LECTURER IN AGRICULTURAL BOTANY in the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 10).

LECTURER IN PHYSIOLOGY—The Registrar, King's College, Strand, London, W.C.2 (August 15).

COWBURN RESEARCH FELLOWSHIP to undertake research in pathology, bacteriology, morbid anatomy or allied subjects—The Secretary, King's College Hospital Medical School, Denmark Hill, London, S.E.5 (August 29).

HEAD OF THE CHEMISTRY–PHYSIOLOGY GROUP IN THE DIVISION OF PLANT INDUSTRY, Commonwealth Scientific and Industrial Research Organization, Canberra—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 130/188 (August 29).

PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER (Ref. 130/190) and a RESEARCH OFFICER (Ref. 130/191) (with honours or higher degree in a biological science, or equivalent qualification; for the senior position, experience of research in population genetics or biometrical genetics would be an advantage) in the Genetics Section; RESEARCH OFFICER (Ref. 130/192) (with honours or higher degree in science or agriculture, or equivalent qualifications, with training in plant pathology or mycology) to undertake plant disease investigations, and in particular to study fundamental aspects of host pathogen relationships and the mechanism of resistance to disease, and a RESEARCH OFFICER (Ref. 130/193) (with honours or higher degree in science or agriculture, or equivalent qualifications) to engage in fundamental studies of plant virus diseases, particularly the mechanism of virus multiplication in relation to resistance and susceptibility, in the Microbiology Section; RESEARCH OFFICER or SENIOR RESEARCH OFFICER (Ref. 130/194) (with honours degree, preferably with botany as major subject, and with postgraduate experience in the fields of work indicated) to undertake detailed studies of pasture plants and others of potential use to Australia which have shown distinct promise, in the Plant Introduction Section; with the Division of Plant Industry of the Commonwealth Scientific and Industrial Research Organization, Canberra—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (August 29).

LECTURER IN GEOGRAPHY (with qualifications in physical geography, preferably geomorphology and biogeography, and ability to teach cartography and field survey) at the Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Auckland, August 31).

READER IN GEOGRAPHY in the Durham Division of the University of Durham—The Registrar, University Office, 46 North Bailey, Durham (September 10).

STANLEY ELMORE RESEARCH FELLOWSHIP IN METALLURGY in the University of Cambridge—The Professor of Metallurgy, Department of Metallurgy, Pembroke Street, Cambridge (September 15).

ASSISTANT IN METALLURGY AND PHYSICAL CHEMISTRY—The Registrar, Loughborough College of Technology, Loughborough, Leics.

ASSISTANT LECTURER IN CIVIL ENGINEERING (with good honours degree and at least two years practical experience)—The Registrar, The University, Nottingham.

ELECTRICAL ENGINEERS AND PHYSICISTS (with first- or second-class honours degree or equivalent in physics or electrical engineering and interest in electronics, servo mechanism theory or analogue computing) in the Ministry of Supply, Farnborough, Hants, for theoretical and experimental research on design and performance of new weapons and associated guidance and control systems; instrumentation of flight trials and analysis of trials data—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.168/53A.

ENGINEER or PHYSICIST (with honours degree in physics, and extensive practical experience of instrument development) in the Division of Atomic Energy (Production), Capenhurst, Chester, to take charge of centre engaged in the development of electrical, electronic, mechanical, pneumatic, chemical and optical instruments used for controlling chemical and physical processes—The Ministry of Supply, Division of Atomic Energy (P), Risley, Warrington, quoting 471.

LECTURER (with thorough knowledge of electron physics, and preferably industrial experience) IN VACUUM ELECTRONICS—The Professor of Electrical Engineering, Electrical Engineering Department, Imperial College, London, S.W.7.

RESEARCH BIOCHEMIST, Senior Grade (with at least five years experience in the basic grade of biochemist), at the National Spinal Injuries Centre, Stoke Mandeville Hospital, Aylesbury—The Secretary, Royal Buckinghamshire and Associated Hospitals Management Committee, 9 Bicester Road, Aylesbury.

RESEARCH SCHOLARSHIPS IN THE DEPARTMENT OF CHEMISTRY, COLOUR CHEMISTRY AND DYEING, and other Departments of the College—The Principal, Technical College, Queen Street South, Huddersfield.

SCIENTIFIC OFFICER (with honours degree in zoology) at the Edinburgh Laboratory of the Scottish Marine Biological Association to join a team of biologists studying plankton ecology in relation to the fisheries—The Officer-in-Charge, Oceanographic Laboratory, 78 Craighall Road, Edinburgh 5.